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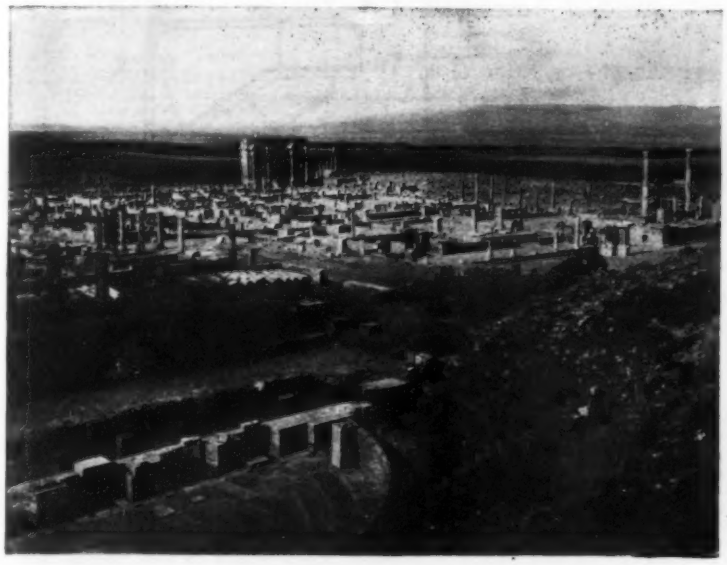
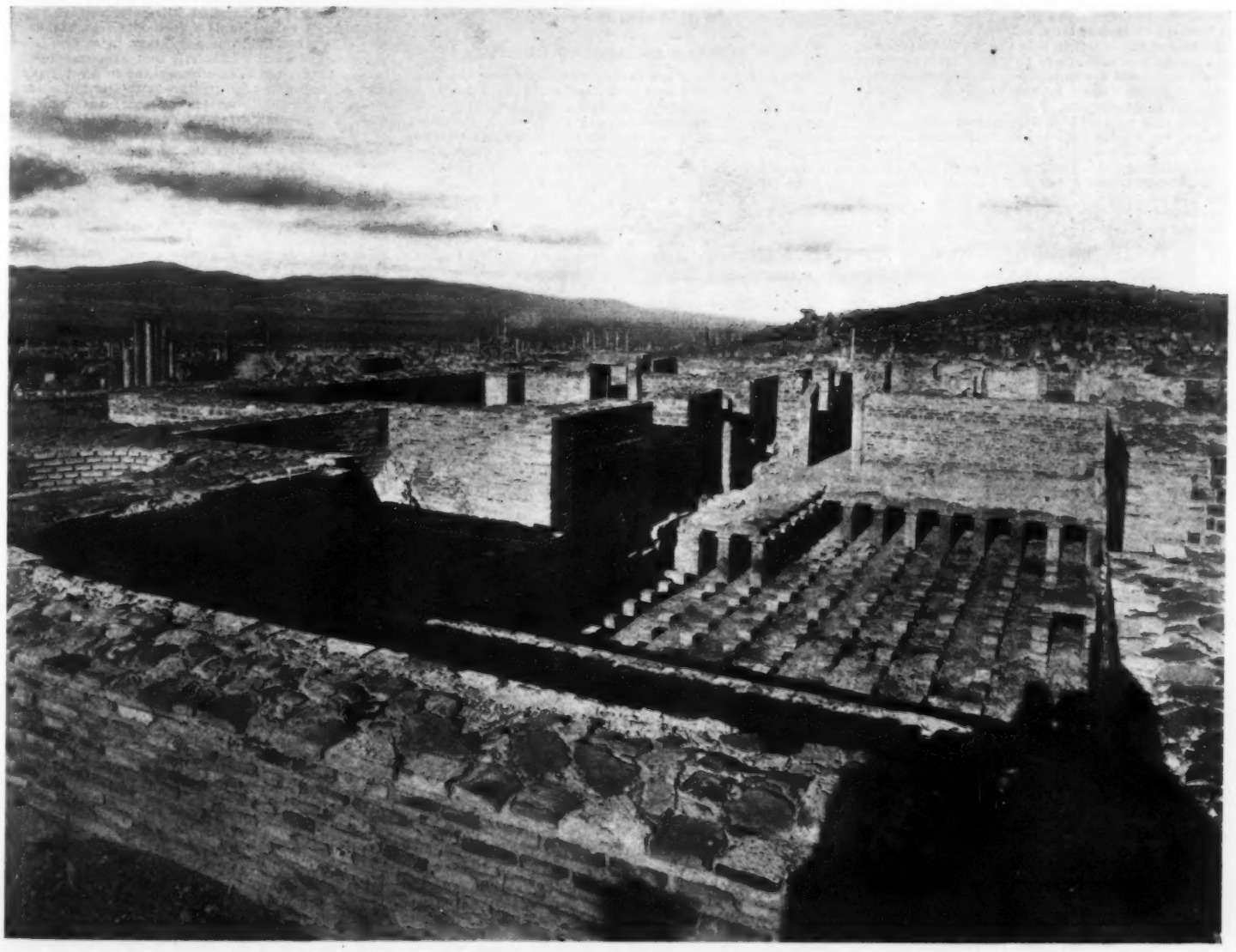
## THE EXCAVATIONS AT TIMGAD.

THE ruins of Timgad, the ancient Thamugadi of the Romans, are among the most interesting of northern Africa. They are situated a few miles from the route leading from the seaport town of Constantine to Biskra, on the border of the desert. Timgad has been not inaptly compared with Pompeii, as after its destruction it lay covered with ashes and the sand of the plain, and it is only within recent years that the French Administration of Fine Arts undertook the excavations which have uncovered the greater part of the ruins. Timgad was one of the most important of the Roman colonies and was situated at the foot of the mountain chain of the Aouras, not far from the Roman camp of



GENERAL VIEW OF THE CITY, SHOWING THEATER.

ARCH OF TRAJAN.



THE EXCAVATIONS AT TIMGAD, AFRICA—THE BATHS.

Lambese, whose ruins still exist. Here was stationed the famous Third Legion which assured the Roman domination in Africa. The city was founded under the Emperor Trajan about 100 A. D. by Lucius Munatius Gallus. It enjoyed a prosperous period under the Empire, but suffered greatly from the religious wars of the fourth century and the invasion of the Vandals (429). After the battle of Tricameron, between the Romans and Vandals, it was left without defense and was burned for the most part in 535 by the Berbers. The Byzantine lieutenant Solomon afterward took possession, and built a fort with part of the ruins; the remains of this fort are seen not far from the city. The Mussulman invasion marks the final end of Timgad, at the end of the seventh century. The greater part of the remaining monuments have since been overthrown by earthquakes and the ruins were covered by the sand of the plain, driven by the sirocco, by the earth washed down from the mountain and by vegetation.

The first regular excavations were made near the end of 1880 by M. Duthoit, under the direction of the archæologist Emile Boeswillwald, and the year following the Triumphal Arch, Forum and Theater were uncovered. Unfortunately this work was stopped and was not taken up again until 1892, under the direction of M. Albert Ballu, archæologist-in-chief, who is at present continuing the work and making interesting discoveries. The city is separated into two unequal halves by the main avenue, the Decumanus Maximus, which passes from east to west. The beginning of this avenue is seen to the right of the engraving; it passes through the Forum, then through the Arch of Trajan, which is seen farther on. The main avenue, which is crossed by a smaller way, the Cardo, forming an intersection at the Forum, is a part of the route which leads from Lambese to Mascula and Theveste. The large flagstones with which it is paved are well preserved and show the deep grooves worn by the chariot wheels. It was bordered over a considerable distance by a series of arcades or porticoes, into which opened a great number of shops; the fronts of these were ornamented with plates of marble or stucco in relief. The porticoes, as well as most of the houses of the city, were covered with red tiles, and a great number of these are found among the ruins. The Forum is a large rectangular space paved with flagstones and surrounded by buildings having a public character. Placed around it were more than thirty statues, representing the emperor and leading personages. All the edifices which border the Forum show a harmony in architectural style, which may be accounted for by the fact that the colony was formed within a few years, and the plans were drawn up by an architect of the Roman school after the orders of the Emperor Trajan. According to the MSS., the city was constructed almost entirely from the reign of Trajan to that of Marcus Aurelius. On the north side of the Forum was a series of stalls separated from the Forum by an open colonnade; these were used as places of assembly. At the west was the Temple of Victory, whose roof was supported in front by four columns. The main portion of the interior, which was ornamented by pilasters, was preceded by an orator's tribune from 30 to 40 feet long, reached by a side staircase. An important building was the Municipal Curia, which had near it a monument to Fortune. The main hall, which was used for municipal assemblies, had at one end a platform raised by two steps and provided with seats for the decurions.

The whole east side of the Forum was occupied by the Basilica, the ancient exchange, this being a great hall 110 by 50 feet, whose roof was supported by two ranges of superposed columns. At the south end of the Forum were some remarkable statues, including a group with the Emperor Trajan, a chariot group, Marsyas and others. Not far from the Forum are the ruins of the temple of Jupiter Capitoline, which was of large dimensions; its façade had six columns of a fine Corinthian style, 50 feet high, or a total height of 60 feet. A large forecourt ornamented with statues opened into an interior court surrounded by arcades. Besides the Baths, which have been recently uncovered, the Theater is one of the principal monuments; it will be remarked in the foreground of the engraving. It is built, as usual, against the side of a hill. Its exterior façade, at each side of the scene, was flanked by two large towers 90 feet high, which relieved the plain appearance of the façade and gave access to the different parts of the theater; these towers were quite handsome, and each was surmounted by a marble quadriga. The Arch of Trajan, situated at the other end of the city, is one of the most complete of the monuments; it has been restored and consolidated under the direction of M. Ballu. The arch is built of a reddish colored stone, which gives it a pleasing effect. It has four large columns of the Corinthian style, besides had two pairs of smaller columns, upholding the entablatures of the niches, each of which had a marble statue. Different varieties of marble have been used in the construction of the monuments, besides three different kinds of stone—a blue limestone, very resistent, which was taken from the mountains to the north of the city; the white limestone of Manah, coming from the quarries 20 miles distant, and a sandstone which was used for ordinary construction and the paving of the smaller streets. The water supply for the city came from a stream about two miles to the south, and was brought by masonry conduits which have been almost entirely preserved. The city is dominated by the ruins of the Byzantine fort, upon a hill about half a mile distant. The excavations are still being carried on, and these will no doubt result in some interesting discoveries.

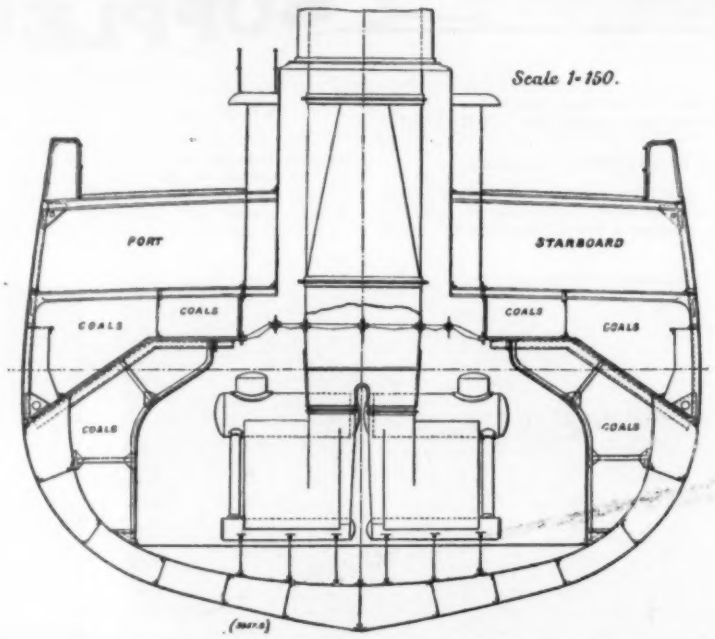



FIG. 2.—THE NEW RUSSIAN HIGH-SPEED CRUISERS.

## NEW RUSSIAN HIGH-SPEED CRUISERS.*

THE Russian navy has just ordered four new cruisers to be built; one at Windau, another at Libau, a third at Nikolaief, and a fourth at Sebastopol; and German naval constructors are naturally gratified at the fact that the design of these four ships follows exactly the lines laid down for the "Bogatyr," a first-class protected cruiser built for Russia at the Vulcan Company's works at Stettin, who were required to furnish copies of every drawing made for ship and engine—many hundreds in all. In many cases also patterns have been supplied to the Russian government, so that the work may be not only expedited, but carried out to exactly correspond with the German ship.

Accompanying this article is a general elevation with deck plan and a cross-section, which shows at a glance not only the arrangement of the protective deck and casemate armor, but also the disposition of the guns.

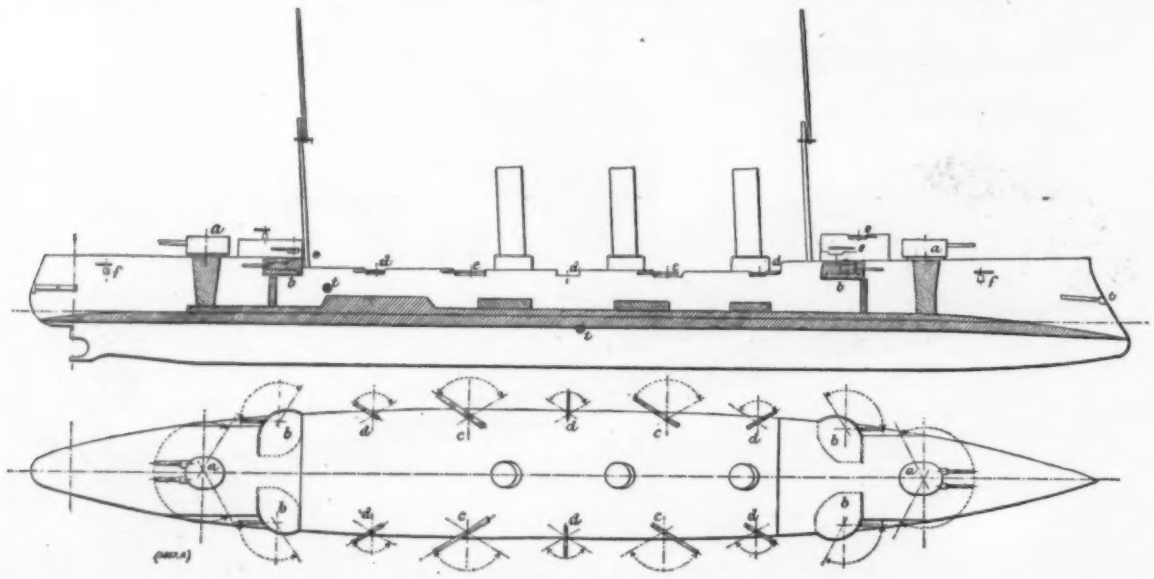


FIG. 1.—THE NEW RUSSIAN HIGH-SPEED CRUISERS.

The "Bogatyr," the first of the type, was designed at Stettin, on the basis of an outline specification of the "Variag" supplied by the Russian government, with the instructions that wherever possible improvements were to be effected; and, as will presently be shown, various improvements were carried out in the direction of increased protection to the guns and of thicker armor for the conning tower, and the normal coal supply has been greatly increased without affecting the speed attained. It has been said also that the five vessels of the "Bogatyr" class have been evolved from the design of recent Elswick cruisers, and notably of the "Blanco Encalada." This statement, however, has no basis in fact, and one or two points in connection with the design almost suffice to prove the statement.

The general dimensions are as follows: Length over all, 134.21 meters (440 feet 4 inches); length at water line, 132 meters (432 feet 2 inches); width, 16.60 meters (54 feet 5½ inches); depth, 10.40 meters (34 feet 1½ inches). With complete equipment and 720 tons of coal on board the vessel will have a displacement of 6,750 tons, and a draught of 6.35 meters (20 feet 10 inches). The principal improvements on the "Variag" and the other cruisers of her class may be briefly indicated. In the first place the new vessels, like the original "Bogatyr," are to be provided with a poop on which the two aftermost 6-inch guns will be placed, so that their platform is raised some 8 feet or 9 feet higher, which gives them considerable advantage in so far as horizon is concerned; and necessarily increases their usefulness in a sea way. It is also important to note that by this change they will not interfere with the line of fire, particularly on the broadside or abaft the beam, of the other 6-inch guns fitted on a lower level on either side of the ship, as shown on the deck plan. The provision of a poop also enables the accommodation of the officers to be improved; a fact of great importance for cruisers intended for service in Eastern waters, because the supply of fresh air and natural ventilation is thereby greatly facilitated.

But perhaps the most important change made is in respect of the protection of the guns; the two poop guns of 6 inches caliber and the two forecastle guns of the same class are worked within armored turrets on a mounting suitable for working both guns simultaneously, whereas in the earlier Russian ship, and, indeed, in many of the Elswick ships of corresponding type, these guns, in common with others of the same type on the broadside, have only had the somewhat limited protection which an armored shield affords. Similarly, two guns on each broadside, which have radii enabling them to fire ahead in line with the keel, and two firing similarly astern, as shown on the plan, are inclosed within casemates, and all of these guns have

* From a German naval correspondent in Engineering.

armored ammunition hoists extending down to the armored deck. Thus, eight of the twelve 6-inch guns are protected by Krupp's special nickel armored plates, and there can be no question that this affords a better protection than a comparatively thin shield surrounding the mechanism of a gun standing on the open deck. There can be no question about the feeling of confidence which such a casemate-engenders in the minds of the gunners, on whose coolness, after all, depends the accuracy of gun fire, and often the ultimate result of naval engagements. The casemate armor forms a complete protection on all sides from the splinters and fragments of burst shell, apart altogether from the great advantage of its being able to resist perforation from direct shot, and experience of naval tactics points to the fact that in future engagements explosive shells will form a very important factor, especially in cruiser attack. It is true that in cruiser design each element is necessarily a compromise, but where a high speed is to be got on a minimum draught and displacement, an important consideration must be given to the maintenance of gun fire, and this can be effectually achieved by adequate protection for the gunners.

The remaining four guns, mounted two on each broadside, are fitted with large armored shields. It is also important to note that the placing of the two 6 inch guns on the forecastle and poop within one turret to be actuated by one turning gear, enables both pairs to be utilized for firing on either broadside. In the earlier ships, notably the "Variag," these two guns were placed side by side with independent mountings, so that the one gun prevented its neighbor from firing in a line at right angles to the keel, and, therefore, abeam. The British navy in the later ships of the "County" class have adopted this system for the 6-inch bow and stern chasers, which are also inclosed in armored turrets.

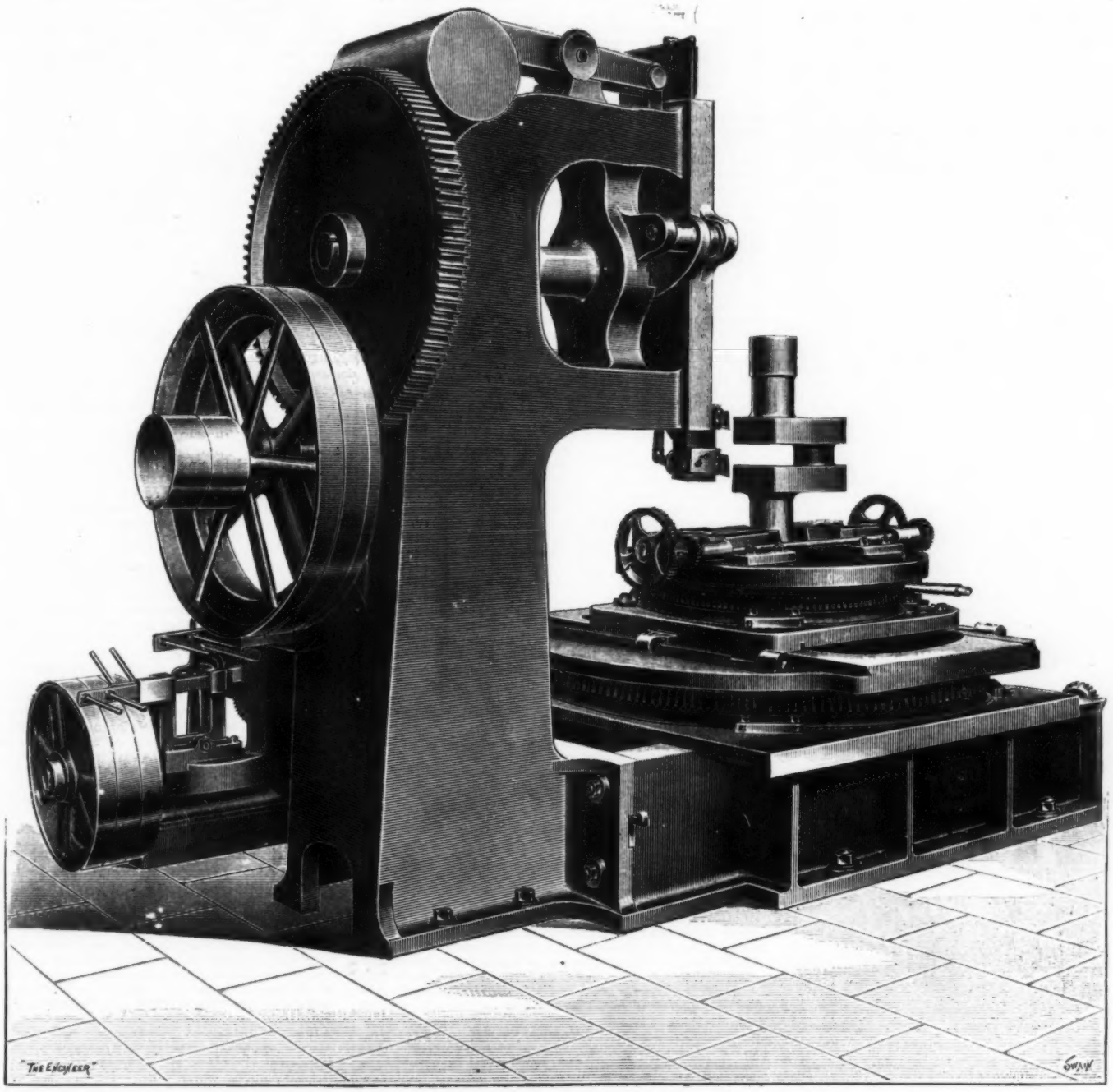
The cross-section of the ship which accompanies this article is interesting as showing the construction of the ship as well as the arrangement of the armored deck. It will be seen that there is a double bottom which extends for the full length of the ship, and in the wake of the engine and boiler-rooms it is carried up to the armored decks with plating as thick as the outside shell, in order to afford protection against torpedo attack. It will be remembered that when the question of the construction of cruisers was brought before the Institution of Naval Architects, at their meeting at Newcastle-on-Tyne, some months ago, this question was raised, and it was pointed out that in high-speed cruisers this system of construction which has been adopted in the "Bogatyr," and also in the four new ships of the same design, was not carried out in high-speed Elswick cruisers. The protective deck has a thickness of 33 millimeters (1 15-16 inches) in the horizontal center parts, while the sloping part of the deck is 73 millimeters (2⅞ inches) special nickel steel, and in view of the curve offers a very good resistance to the penetration of shell, and is eminently satisfactory when the displacement of the ship and her speed are taken into account. And here, before departing from the question of protection, it may be said that protection of the turret guns is 125 millimeters (5 inches) in thickness at the front, the material being of hard steel, while at the back it is 90 millimeters (3½ inches) in thickness of soft nickel steel; the ammunition hoists are also of nickel steel 75 millimeters (3 inches) in thickness. The casemates are 80 millimeters (3¼ inches) thick in front and 35 millimeters (1¾ inches) at the back.

There is a further improvement in the "Variag" design, in respect that, in addition to the magazines forward and aft, there is one of considerable size amidship, so that the supply of ammunition to the guns amidship is much quicker and is maintained with less likelihood of danger. There are hoists to all the guns, worked by electric power, but fitted also with gear for operating them by manual labor. As to coal supply, it may be noted that while the enormous supply in the "Variag" was given as 600 tons, it is 720 tons in the case of the vessels of the "Bogatyr" type, the total coal capacity being 1,100 tons.

Engineering has already given very general particulars in its previous article on the "Bogatyr," and as these hold good so far as the four new ships are concerned, it is not necessary here to repeat them; but it should be stated that while the "Variag" had Niclausse boilers, the "Bogatyr" and the four other ships now being ordered will have sixteen Normand-Sigaudy boilers to supply steam to the twin-screw triple-expansion four-cylinder and four-crank engines which are to develop 20,000 indicated horse power and to give a speed of 23 knots. The general appearance of the vessel will be easily seen from the elevation which accompanies this article, and which is of importance, as former illustrations published have not been accurate, the three funnels being placed too far forward, and the after-part of the ship made too long.

## LOCOMOTIVE CRANK AXLE SLOTTING MACHINE.

AT a meeting of the Institution of Mechanical Engineers early this year, Mr. Wicksteed described a machine for slotting crank webs which was far more rapid in its action than a milling machine for the same purpose. Through the courtesy of Joshua Buckton & Co., Limited, the makers, we are enabled to illustrate this remarkable tool, says The Engineer, to whom we are indebted for our engraving and the particulars. The engraving almost entirely explains itself. The machine is for finishing the profiles of the webs of locomotive crank axles. Two cuts are taking place simultaneously, one upon each web, and by means of patent double-cutting tool-boxes a cut is taken both on the down stroke and on the up stroke of the ram. On some crank forgings a large amount of material has to be removed by the slotting tool, especially in rounding the corners, and the machine is of such power that the downward cutting tools will remove material up to 2 inches deep, so as to cut off thick and thin before it within ¼ inch of the finished size. On the upward stroke of the ram the alternative tools come into operation and remove the last ⅛ inch, leaving good corners on the work and a bright smooth finish, so that once going round the crank finishes the profile of the web ready for erecting in the locomotive. The table of this machine is specially constructed for facility in fixing the crank axle in position. Half the axle drops down into a stirrup forming part of the top table, and it is there supported by a dead center, while the upper part is held to the table by a pair of concentric vises. Thus the axle is mechanically fixed in a true vertical line. The profiles of cranks are of very various design. If a workman is provided with a drawing giving him the distance from the center of the axle to the radii of the different curves, he can adjust his table with scales marked in plain figures, so as to get the exact position of the radius of each curve required to coincide with the axis of the large revolving table of the machine.




CRANK WEB SLOTTING MACHINE.

The machine, besides being specially designed for locomotive crank axles, is equally well adapted for finishing the profiles of such webs. For this purpose the parallel vises are removed from the table; the web, which may be 4 feet long, is fixed to the table, and without refixing, it may be slotted all round both the internal and external curves without leaving any mark to show where the curves run into each other, and the finish of the profile is bright enough to go into the ship without any hand labor.

[Continued from SUPPLEMENT, No. 1330, page 21318.]

## PROTECTION OF FERRIC STRUCTURES.*

By M. P. WOOD, New York, Member of the Society.

### LINSEED OIL.

61. LINSEED oil has a specific gravity of 0.928 to 0.953. The oil from an average sample of linseed extracted by various processes shows:

| HOT PROCESS. | Per cent. | COLD PROCESS. | Per cent. |
|---|---|---|---|
| Carbon | 75.17 | Carbon | 78 |
| Hydrogen | 10.98 | Hydrogen | 11 |
| Oxygen | 13.85 | Oxygen | 11 |
| | 100 | | 100 |

The carbon disulphide process gives more oxygen and less carbon.

It corresponds to the formula: $\left\{\begin{matrix}C_{18},\ H_{32},\ O_3\\ C_{20},\ H_{34},\ O_3\end{matrix}\right\}$ Mulder.

It is anhydride of linoleic acid, $C_{18}H_{32}O_2$, an acid peculiar to all siccative or natural drying oils, and when fully oxidized by exposure to the air, forms oxylinoleic acid, $C_{18}H_{32}O_5$.

Hazura and Bower (Monatschr., vol. lix., p. 459) found that the rate of oxidation and consequent hardening of this and other siccative oils, depended on the ratio of linoleic and linolenic acids present.

Analysis of ripe linseed gives:

| | Per cent. |
|---|---|
| Albuminous substances | 24.44 |
| Gum, sugar and cellulose | 34.00 |
| Oil | 30.73 |
| Ash | 3.33 |
| Water | 7.50 |
| | 100 |

62. Unripe seed, or seed from flax raised for the fiber only (the condition from which most of the commercial oil is obtained) contains nearly 10 per cent of water. The yield of oil from the different classes of linseed varies only from 23 to 28 per cent of the weight of the dry seed. Linseed yields in the process of extracting the oil, viz.:

| | Per cent. of oil. |
|---|---|
| Cold process | about 20 |
| Hot process | " 27 |
| Carbon disulphide process | " 36 |

Or 15 to 18 pounds of oil per bushel of commercial seed, by the most improved processes of extraction.

63. Ireland, England, Belgium and Central Europe raise the best flax for fabric purposes; the seeds gathered from these sources being unripe, furnish poor, thin, watery oil. Russia has the largest acreage in the world devoted to the raising of flax for seed purposes, and furnishes about one-sixth of the world's supply, the yield being about eight bushels of fifty-six pounds to the acre, the fiber being of minor importance, being woody and subject to great waste in the preparation of it for fabric purposes. Russian seed is exported to other countries for seed purposes as well as for its oil. Large quantities of hemp are sewn in Russia with the flax, but as this furnishes a siccative oil, its presence is not an improper adulteration, such as the seeds from the rape, mustard, colza and many other plants called "flax dodders," that furnish a *non-drying* oil. The adulteration from the seeds of these plants is so widely practised that the waste product of the oil mill in the form of oil-cake, formerly a valuable cattle food product, is now so strongly impregnated with the biting taste of the mustard and other acrid substances that cattle refuse to eat it, and it is chiefly used for fuel or fertilizing purposes.

64. The American linseed that furnishes 20,000,000 gallons—about one-tenth of the world's supply of linseed oil—is also strongly adulterated with mustard and other non-siccative oil seeds that render the oil-cake almost valueless for a cattle food, besides contributing their quota of green, unripe seeds to the unripe linseed oil pool.

India furnishes about one-eighth of the world's supply of linseed. It is grown as a mixed crop for the seed only, the flax staple being of inferior quality and only 18 to 20 inches long. The climate appears to develop the oil-producing qualities of the seed, it yielding a larger amount of oil than seeds grown in a colder climate, though the colder the climate the better the oil. India seed is mixed with colza and rape seed, both furnishing non-drying oils hard to separate from the linseed. Both are used for lubricants, burning, and in the manufacture of India rubber compounds.

65. The vegetable siccative oils of commercial importance are twenty in number, the principal of which are linseed, poppy, hemp, walnut, sunflower, grape, Scotch and silver fir, and spruce. The specific gravities of the whole number (20) range from 0.9202 to 0.9358, varying so little that the hydrometer test is of little moment to determine their character. The vegetable non-siccative oils of commercial importance are 76 in number, the principal ones being the castor (specific gravity, 0.964), olive, and cottonseed (specific gravity, 0.9306, almost identical with linseed), resin, almond, beechnut, horse chestnut, hazel nut, peanut, croton, sesame, colza, rape, mustard, with specific gravities ranging from 0.913 to 0.942. They mix thoroughly with each other as well as with the siccative oils, and the specific gravity of a pure linseed oil can be easily counterfeited, even if its quality cannot be. Vegetable oils additional to the above, used medicinally and for soap, burning, and food, are 85 in number.

66. Vegetable oils, volatile and essential, number 134, or a total of 293 non-drying oils available for the purpose of adulteration. Add eighty animal and fish oils to the above, and it may be conjectured the source from which a yearly supply from the whole world of 200,000,000 gallons of linseed oil can supply a demand for about 450,000,000 gallons of paints, varnish, japans and other uses, including the wastes of manufacture.

67. If the flax is raised for the fiber, the seeds do not mature at the same time, hence they furnish a thin, watery oil with a greater quantity of the albuminous substances, gum, sugar and cellulose, called "mucosities," than the 54.44 per cent to 58.50 per cent found in ripe seed. Unripe or mildew linseed is no more capable of furnishing a good oil than a green apple will make either good cider or good vinegar; an unripe grape, good wine; or grain or corn harvested in the milk will make good bread; and no amount of juggling in the subsequent manipulations of the paint manufacturer can replace the simple operations of nature, or ripen her unripe products or produce them from synthetical compounds.

68. The composition and properties of the siccative oils have been but little studied since Mr. J. Nelson Neil was awarded the Isis Gold Medal of the Society of Arts in 1832 for a paper read before that society on "Oil Boiling and Varnish Making" (published in The Transactions of the Society, vol. xlix., part 2), which treats so exhaustively upon the modes of manipulation, recipes and precautions to be used, that the paper is the foundation for all subsequent accounts and modes of manufacturing varnishes. The additions and modifications which have been worked out since that time have not materially altered the processes of Mr. Neil, either in the betterment of the quality of the varnish or the oil product, but relate more particularly to a shorter time and possibly less cost of manufacture than given by Mr. Neil, which comprised the application of direct fire to the kettles instead of the steam jacket kettles and devices used by later experimenters and manufacturers.

69. These experiments of Mr. Neil were followed by the experiments of Mr. M. E. Chevreul, who contributed a paper in 1856 to the Annales de Chimie, corroborating Mr. Neil's deductions upon the drying of siccative oils, and by him clearly laid down, viz.:

First: That it is the absorption of oxygen by the siccative oils and the change of the oleic, margaric and stearic acids of which they are composed, and the chemical combination with each other in the presence of oxygen into the linoleic and linolenic acids, that is the cause of their solidification, which term he thinks more clearly defines the action of the oil than drying, which in general may mean evaporation, which is a term adaptable to all liquid bodies, or rather indicates the removal of liquid from all bodies. This definition appears to be apropos to many of the latter day cheap mixtures called paints; the difficulty experienced with some of which is not to have them dry in a reasonable time, but to have them keep liquid long enough to spread them at all.

Second: That the oxidation of the oil is a chemical process and naturally inherent in itself. The action of heat, as in boiling, hastens the drying or resinification of the oil by removing the water and mucosities. That all substances which can be used as driers must be such as are capable of parting with oxygen or dissolving in it; and being of themselves oxidizable in combination, they in that way increase its absorptive power. There is a class of driers (white copperas, for instance) which act while mechanically suspended or in contact with the oil, and increase its oxygen absorptive power by their presence, but leave no increase of drying power when withdrawn.

70. The substances that act catalytically part with some of their oxygen in the oil, and become to a certain extent deoxidized, and again coming into contact with the air either mechanically blown through the combined mass of oil and driers, or by surface exposure in the settling tank or barrel, recover their primal condition, and are ready to do the same work over again. It is the necessity for the reoxidation of the driers that causes the general adoption of the air agitation and steam processes now in general use for the boiling of oil and manufacture of varnishes, etc. These driers, without becoming in any way altered, induce an alteration in the linseed oil subjected to their operation. We may imagine this action as similar to that by which spongy platinum explodes a mixture of oxygen and hydrogen, or a platinum wire is kept red hot by the vapor of ether.

71. Prof. Chas. W. Vincent's experiments in 1859 were upon the line of boiling oil without the presence of driers, and that a high temperature was not necessary. The temperature used by Mr. Vincent was that due to steam at forty pounds per square inch, 267 degrees Fahr., used in a steam jacketed kettle in connection with mechanical agitation by revolving blades and a current of compressed air moderately heated by the act of compression. This process is that in general use at present in the manufacture of linoleum, and it is believed that the Germans practised this method many years preceding 1859. Prof. Vincent's conclusions, drawn from experiment, were that air blown through the mass of heated oil *is not* as important a part of the process as many have assigned to it, and in reality effects nothing toward making the oil a drying one. He boiled linseed oil with air alone, *but without driers*, for three days consecutively, keeping up a high temperature the whole time, and the resultant boiled oil required precisely the same time to dry as the raw oil from which it was prepared. The body, however, had become so much increased that its consistency was more that of a varnish than an oil. In the oil subjected to the heat alone for the same time, without any air, except such as came to it in contact with its surface in the kettle, there was no such increase in its consistency as in the former case; the oil simply became more greasy, had less difficulty in penetrating the capillary tubes of paper, plaster, etc., than it previously had, and had decidedly *less* drying power. The oil that had been boiled with the air blast was less greasy and had a greater consistency. Briefly, the surface exposure to the air and the heat secured a sufficient amount of body. The driers produced any required shade of color in the oil, and reduced the time of drying from three and four days, for the raw oil, to six hours in the summer and eight hours in the winter for the boiled. Boiled oil that is subject to long voyages at sea is apt to become fatty and not free working. This is due to the agitation it gets from the motion of the ship while it is under the increase of temperature due to the hold or cargo space in the ship, being, in fact, a long continued low temperature and agitation process of boiling. The manufacturer guards against this result by adding to boiled oil for shipment by sea about one-fourth its volume of raw oil, the oil becoming brighter in consequence of the addition. Prof. Vincent's steam kettle process of boiling gives an oil of a lighter shade than the direct fire or high temperature process. In both processes acrylic acid ($C_3H_4O_2$), a monobasic acid (oxidized from acrolein $C_3H_4O$) and very soluble in water, is produced, the vapors of which escaping during the process of boiling are very irritating to inhale, and are highly corrosive to ferric bodies. Its presence is due to the decomposition of the mucosities in the raw oil under the influence of the heat, and only indicates the slower decomposition of these substances in a raw oil vehicle for a paint; the slower process of solidification of the raw oil inclosing them, as it were, in a film of the vehicle, to develop later into a destructive agent of the paint. The removal of these mucosities is absolutely necessary in the manufacture of linoleum, baking japans, and varnish; and if detrimental there, it must necessarily follow that they are equally so in a paint.

72. Prof. Sacc's experiments in brief were, 2,500 grains of oil boiled for ten minutes only, with 30 grains each of litharge and red lead, and weighed after 24 hours' exposure to the atmosphere, the oil had lost only 60 grains. This sample increased 20 per cent in weight after complete resinification. A second sample boiled until there was a loss of 5 per cent in weight of the oil, the product assumed a molasses consistency, and did not resinify after fifteen days' exposure to the atmosphere. A third sample boiled to a loss of 12 per cent became a caoutchouc-like mass that the atmosphere had no effect upon whatever. It was insoluble in alcohol, ether, chloroform and bisulphide of carbon; boiling naphtha only dissolved traces of it. The only action which dilute acids had upon it was to extract a small quantity of the oxide of lead due to the driers. In properly prepared varnishes and paints from pure linseed oil, the gain in weight after thoroughly dry is from 8 to 10 per cent of the vehicle, and it is heavier than water. Any paint that does not show a marked increase in weight in drying can be set down as having but very little siccative oil in its composition, and is one of the hundreds of bastard compounds that masquerade under the guise of paint, with more resin, fish and hydrocarbon substances in its vehicle than linseed or other siccative oils, and whose drying power or evaporation is principally expressed in the amount of benzine it can carry and still keep the pigments (good or poor) afloat.

73. The sulphuric acid process of boiling has been adopted by a number of manufacturers. It furnishes an oil of light color which dries well and rapidly, mixes with all pigments without leading to any discoloration. Whites retain their purity of tone unchanged, but with all these points in its favor, the process cannot be recommended for the preparation of a vehicle to be used for a ferric protective coating. Briefly, the oil is first treated with a dilute sulphuric acid bath (containing about 30 per cent of sulphuric acid) which is agitated with the oil by the air blast *to dehydrate* it, but is said to be not strong enough to carbonize it. After standing to allow the oil and acid to separate, the oil is run off into the usual steam jacketed kettle heated to about 260 degrees Fahr., air is blown through the mass, while a solution of manganese linoleate in some hydrocarbon spirit (probably benzine) is added gradually during the process of heating and blowing. Cautionary care is required *not to add too much* of this material. It is the writer's opinion that this caution should extend to the point of not adding any manganese associated with any hydrocarbon vehicle to the oil, and that prohibition should extend to the use of any sulphuric, nitric, or other caustic acid of any strength to the oil in its preliminary stage. It is almost impossible to clear an oil of either high or low specific gravity, of any acid of whatever strength of solution to which it may be exposed. More or less of the clarifying acid will be held in the oil either free or in combination with the water in the oil, that even a long washing with water, aided by an air blast agitation, *will not remove*. Kerosene, naphtha, gasolene, etc., are purified by treating with sulphuric acid and then thoroughly washed with water and a long agitation by the air blast, and are then often found to contain acid enough to perforate the tin cases in which they are shipped. The slight improvement in the color of the boiled oil by this process, is a very poor recommendation for its use. The same results are obtainable by the ordinary steam kettle process, using well known mineral substances; for instance, the zinc and manganese salts will remove or throw down the mucosities, clear the oil to any desired shade, and cause it to dry promptly, while the water in the oil will be evaporated naturally by the heat, and the dangers of the sulphur element avoided.

74. A series of interesting experiments upon the action of various mineral and metallic substances called "driers," upon boiled linseed oil, to determine the effect of the same on the color of the oil and time of drying alone, were made by Mr. Frank H. Thorp, S.B., published in The Journal of Chemical Industry, vol. ix., p. 628, also in the SCIENTIFIC AMERICAN SUPPLEMENT, No. 757, vol. xxx., July 5, 1890. The details of the experiments are too long to include here, but the following results are probably as trustworthy as those noted by earlier experimenters. The oil experimented upon was in every case from the same barrel, and was a very light colored, cold pressed Calcutta raw linseed oil, specific gravity 0.93—50 c.c. weighing 45.7 grammes. The several samples were treated in glass beakers arranged in a sand bath under temperatures from 220 degrees Fahr. to 300 degrees Fahr. In general, the temperatures from 230 degrees Fahr. to 275 degrees Fahr. gave the best results. The weight of oil under the test was in each case the same, 45.7 grammes. The time of actual boiling was from 1½ to 2½ hours, and the percentages of driers varied from less than 1 per cent to 2 per cent by weight of the oil treated. Litharge furnished an almost colorless oil of firm film, drying in from 6 to 10 hours. Lead

* Presented at the Milwaukee meeting (May, 1901) of the American Society of Mechanical Engineers.

carbonate, lead acetate, lead borate, each furnished slightly colored oils with good films, drying in the order named, in 10, 12, and 20 hours. Red lead, lead chloride, lead tartrate, furnished dark-colored oils of good films, drying in from 20 to 24 hours. Red lead and litharge, 2 per cent of each, also the other lead salts mentioned, with larger percentages than two of each, gave dark-colored oils, all with firm films, drying in about 24 hours.

75. Of the lead driers, litharge gave the best results both in color, film, and drying qualities. Care was necessary in the use of this drier to not overheat the oil, thus deepening its color. The zinc salts, the acetate, borate, citrate, oxide, and sulphate, furnished nearly colorless or slightly colored oils with fairly good films, but their time of drying was from 36 to 46 hours. Larger amounts of these driers than 2 per cent shortened the time of drying, darkened the color of the oils, but they did not clarify satisfactorily.

76. The acetate and borate are the best of the zinc salt driers, but none of them act catalytically upon the oil as the lead and manganese driers do, but act mechanically or only while present (like white copperas), to throw down some of the mucosities, but do not cast them all out or set up the combination changes necessary to form the linoleic compounds required in a good drying oil. The manganese salts, viz., the acetate, borate, sulphate, oxalate, and tartrate, all gave colorless oils, drying with good firm films in from 20 to 36 and 40 hours. The citrate and formate gave slightly darker-colored oils, drying in about 24 hours with good firm films. The manganese borate with quantities varying from 1 to 3 per cent of the oil and with temperatures of 220 degrees Fahr. to 230 degrees Fahr., gave the best colored and drying oils obtained in the whole line of experiments. The other manganese salts with larger than 1 per cent of driers with temperatures from 250 degrees Fahr. to 300 degrees Fahr., gave colored oils of unsatisfactory drying power, some of the samples being tarred. No definite conclusion can be drawn from Mr. Thorp's experiments as to the relation between the quantity of driers dissolved in the oil, and the time of drying of the oil. The action of the several classes of driers, as well as the various members of them, was erratic and the drying result appeared to be governed quite as much by the temperature of the bath, time of boiling, and agitation of the oil during boiling, as by the chemical employed. One per cent by weight of litharge and the lead driers, and two-tenths of 1 per cent of the manganese salts, were all that were required to give good bright colored oils of good drying qualities with firm films, and not all of these amounts of driers were taken up by the oil, but some was recovered in the residuum.

77. Of the many substitutes for linseed oil neither space nor patience can be given to note them. They are numbered by the hundreds in the Patent Office records, and outside in the formulas of the many paint compounders of the day, and are as uncertain and indefinite in character as the pigments which are assembled with them under the guise of paints. Linseed or other siccative oils of low commercial qualities, and in small quantities are mixed with one or more of the score of flax dodders or buffums, resin, fish, burning and soap fat oils, india rubber, and other impure substances liberally dashed with benzine of high or low degree and braced up with a bung-hole boil of umber or other cheap driers, and then presented to the supply agent and public as pure linseed oil at a price below the regular market quotations of linseed oil from responsible business firms. The purchasing agent, as well as most of the master painters (except in a few cases), have not the laboratory, chemical apparatus, or technical knowledge to detect the fraud; the results only being made patent by the slow gnawing of the tooth of time, and at a period when it is too late to remedy except by the scraper, burning torch, and a new coating that may or may not be better than the one that it replaces. Probably 70 per cent of all the oils, paints, and varnishes manufactured in the world is applied to structures of minor importance, and which are destroyed in the course of time by other causes than corrosion. The coating of these structures is generally more a question of looks than physical conditions, but the other 30 per cent is used upon the largest, most costly, and important engineering structures created by man, urged on by the strong spur of competition, honor, and hope of gain. These require suitable protection from corrosion from the very hour the materials leave the rolling mill, foundry, or forge until they are in the finished structure, and need more then than during construction. The most casual inspection of the ferric structures that line our railways and are counted by hundreds in the various cities of the country will show that they have not thus far received the intelligent treatment their importance or life demands.

### DECAY OF PAINT.

78. A coating of paint may appear to be a very simple thing, and it is, when applied to a house or barn and both left to their fate, but when applied to an important engineering structure, with all the vicissitudes of service in the extremes of heat and cold, sunshine and storm, atmospheric and other gases from natural or manufacturing sources, from corrosive liquids and solids, it is a different matter and requires more engineering skill to devise it, more chemical knowledge to compound, and technical details to get the right thing in the right place at the right time, in the right manner, and in the right amount than the general run of master painters can or do give to the subject. If the influences to which a coating of paint is to be subjected are known, it can generally be determined in advance whether it will be durable. For instance, zinc white or oxide (ZnO, specific gravity, 5.42) applied as an external coating absorbs carbonic acid from the air and some moisture, changing to a carbonate of zinc ($ZnCO_3$, specific gravity, 4.44). During this change there is an increase in volume from 14.9, as an oxide, to 28.1 as a carbonate. This change from an oxide to a carbonate is a chemical one and occurs during the process of drying, but the *change in the volume* of the two substances exerts a mechanical action also in the atoms of the pigment to not only disrupt them and leave them loose and easily carried away by the wind, rain, etc., but cracks and loosens the oil menstruum in which the pigment is embodied, as well as its bond to whatever surface over which it is spread. But if the zinc oxide coating is applied in a closed room, though the air contains the same amount of carbonic acid, or even more than the external air, the oxide does not change to a carbonate, as the necessary moisture is lacking, hence zinc oxide for internal coatings is durable, but for outside coatings is perishable.

80. Red lead ($Pb_3O_4$, specific gravity, 9.07) remains unchanged under ordinary atmospheric conditions, but if the air contains hydric sulphide, as it does in many manufacturing establishments and towns, to a notable extent, it will, by inexorable chemical laws, change the oxide to a sulphide of lead (PbS, specific gravity, 7.13), and this chemical change (usually denoted by the blackening or discoloration of the coat) will also be accompanied by an increase in volume of the sulphide of about 33 per cent, this increase acting mechanically to disturb the bond between the pigment menstruum and surface coated.

81. The addition of carbonate of lime (chalk) to an iron oxide pigment, whether made from the natural iron ore, or from calcined copperas ($FeSO_4 7H_2O$) to neutralize the sulphuric acid developed in the calcination of the copperas or roasting of the natural ore (as heretofore noted) is another instance in which an inexorable chemical change in one of the pigment's loose substances is accompanied by a change in its specific gravity, its corresponding change in volume, and a mechanical action to reinforce the chemical action due to the raw oil vehicle loaded with its charge of driers, whose function is to either decompose or consume by a slow combustion the mucosities in the oil while attempting to dry. All these instances are similar in effect to what would occur in the plastered wall of a building if the mortar used in it, when partially dry, should begin to increase in volume to the amounts as given above. Other instances could be cited, but these show that the pigments of the coating can be so chosen as to preclude the destruction by them of the coating, but that it is almost impossible to guard the menstruum from the injurious influences inherent in the composition of the pigment, that is changed in character after its application by inexorable chemical laws. Hence the absolute necessity that an order for a protective paint should include the conditions it is to be subjected to in use.

82. In addition to the preceding remarks upon iron oxide, graphite, and other paints, and the several tests given in detail of a few of the many paint compounds of the day, it may be noted, viz.: All pigments can be grouped into three classes according to their affinity for linseed oil.

First: Those that form chemical combinations called soaps and are generally the most durable. They consist of lead, zinc, and iron bases, of which red lead combines with the oil to the greatest extent; next, the pure carbonate white lead made by the Dutch process, followed by zinc oxide and iron oxide, turkey umber, yellow ocher; also, faintly, the chromates of lead, chrome green, and chrome yellow.

Second: Pigments of this class, being neutral, have no chemical affinity for the oil; they need large amounts of driers, either combined with and carried by the oil, or as free driers. They include all blacks, graphites, slates, slags, vermilions, Prussian, Paris, and Chinese blues, terra de sienna, Vandyke brown, Paris green, verdigris, ultramarine, carmine, and madder lakes. The last seven are transparent colors, and are better adapted for varnish mixtures and glazing.

Third: Pigments of this class act destructively to linseed oil. They have an acid base (mostly tin salt, hydrochloride of tin and red wood dye) which form, with the albuminous and gelatinous matters in the oil, a jelly-like compound that does not work well under the brush nor harden sufficiently, and can be used in a varnish for glazing only. Among the most troublesome are the lower grades of so-called carmines, madder lakes, rose pinks, etc., which contain more or less acidulous dyes, forming with linseed oil a soft paint, that dries on the surface only and can be peeled off like the skin of a ripe peach.

83. Catalysis, a term introduced by Berzelius, and by him applied to the changes that sugar solutions undergo in the process of fermentation, and now used to denote the changes that certain substances by their mere presence effect in other bodies without themselves undergoing any apparent change. Catalytic action is a potential agent in the decay of paint coatings, and manifestly has not received the attention from paint chemists and compounders that its marked action on the life of a coating warrants. The present efficiency of the incandescent gas light is wholly due to catalytic action between the substances that compose the mantle when excited by the combustion of the gas. In the development of this light all of the rare mineral oxides and metals and the oxides of the baser metals, chromium, alumina, cobalt, manganese, nickel, and iron, when associated with thoria in the mantle, have been found to act as catalytic agents to carry, condense or absorb oxygen that increases the flame temperature of the mantle and consequently increasing the light. This flame temperature in some cases reaches the point where volatilization of some of the baser metals and oxides ensues. Charcoal, powdered glass, porcelain, fluor spar, crystallized quartz, pumice stone, and other kindred substances are also found to act as catalytic agents in combustion, but do not develop so high a flame temperature in the mantle as the other substances above noted.

84. Combustion of any substance may be quick and attended by a high temperature, as in the case of the incandescent gas light, or it may be of low temperature and extend over years of time, but the amount of heat evolved from the destruction of the substance and the resultant products of combustion, or decomposition, are the same in all cases, even if the physical effects are apparently different.

85. Nearly every substance in a paint coating has been found to be catalytic to some other substance, either in its own class as a so-called inert mineral pigment, or in the chemical class of oxides having a lead, zinc, iron, or other metallic base. Individually, they may be apparently unaffected by long exposure to the air while in their loose state or in packages or bulk; but when mixed together, they take up moisture or oxygen to a greater or less degree, either by absorption in mass or by condensation upon their surfaces, and catalytic action ensues. The oil menstruum and driers are catalytic of themselves, and when mixed with the pigments act more energetically as carriers of oxygen even when the coating is apparently dry. In all the pigments and menstruums, the one that is the most refractory, or that is the most resistent to oxidation in whatever form the oxygen may be presented, is the one that acts the part of the thoria in the gaslight mantle, becoming the negative or non-consumable substance, that, though excited to a greater activity by the presence of the other substances in the paint compound, retains its resistance to a change the longest at the expense of the other associated substances. Thus far, lampblack and graphite in their subdivided form as pigments, appear to be the only substances not subject to catalytic action, or if it is present it is so weak that the life of the coating is not materially affected from this cause.

### PAINTING AT THE MILL.

86. Many engineers are advocating the plan of having a coating of protecting compound applied to iron or steel at the rolling mill as soon as possible after it has left the rolls or hammer, and while the material is hot. The *hot* part of this plan is the only part to commend. All material from the forge or rolling mill has a tough, thick or thin (as the case may be) coat of loose or partly loose scale, that adheres closely for the time being, but on a short exposure to the air with a few changes of temperature due to the mill or storehouse conditions, releases its tension and is ready to fall off whenever roughly handled, as in the course of loading and transportation. No amount of brushing which any rolling mill employe would or could give to the material in its hot or half cold condition, would remove this scale, and if the painter were present with his pot of paint, it would get on over scales and all, and no inspector could prevent it. The quality of this paint, even if rightly applied, would always be in question, and no contractor could be in any way sure that the contract requirements had been complied with, either in the removal of the scale or the composition of the paint. All the machining operations are accompanied by more or less lubrication of the tool, and the oil used is invariably the cheapest to be had for that purpose, and has in general been used over and over again, is dirty and sour, and more or less decomposed, and carries enough hydro-carbon elements to evaporate to a dirty surface skin, hard to distinguish from the coating applied at the mill, the sequence being that the inspector, if careless in the discharge of his duty, and anxious to get the work out of the shop, and to show a large day's work, does not notice the grease or other dirt due to the machining process which is not removed, but coated over by the ever ready painter, anxious to show his great day's labor and, as a class notorious for scrimping everything which calls for manual effort, and jealous of any attempt to confine him to a procedure at variance with what he thinks is a special function of his own craft. Rather let the material go from the mill or forge to the storehouse or construction shop, protected as far as possible from any unnecessary exposure to the elements, and when machined, during which process the greater part of the scale will be removed, and when the several parts are assembled in their relative positions and ready to be riveted up into their permanent places in the structure; if it is done at the shop instead of *in situ, then and there* is the place for the inspector to determine if the several parts are not only properly machined, but also properly cleaned from the scale which has not been removed by the machining process and handling, but, that the grease and dirt is also removed *in his presence*, and the first coat of the paint is applied under his eye in a manner as to the conditions of temperature, frost, fog, wet or dry, and a *quality of paint* which will insure a proper protective result. Nothing can serve as a cloak to hide *his own responsibility* in the matter. One inspector and inspection at the last and final stage, is better than two or more inspectors and inspections strung along over a chain of operations comprising months of time and often hundreds of miles between the links.

87. What results, other than a prompt corrosion, could follow where an engineer, on his examination of construction work in progress for his own firm, reports: "The removal of the rust spots and mill scale was being done by *putty knives and whisk brooms*. Steel brushes were also used. [Evidently as a minor appendage to the broom.] If there was *anything unusual* in this method of cleaning at the shops, *it was on the side of thoroughness*. After cleaning, the plates *still showed thin yellow rust spots*, and these showed plainly but of a darker color after the oil coating was applied." (The italics are the writer's.)

88. Every atom of the rust or mill-scale thus left in place and coated was electro-negative to the coated surface, and ready to commence the process of corrosion whenever moisture from any source reached it. The thin film of oil from 0.001 to 0.002 inch thick would not delay corrosion much longer than the time required to dry. If the oil was of the bung-hole boiled variety, containing 7 to 10 per cent of water, corrosion would start the more promptly.

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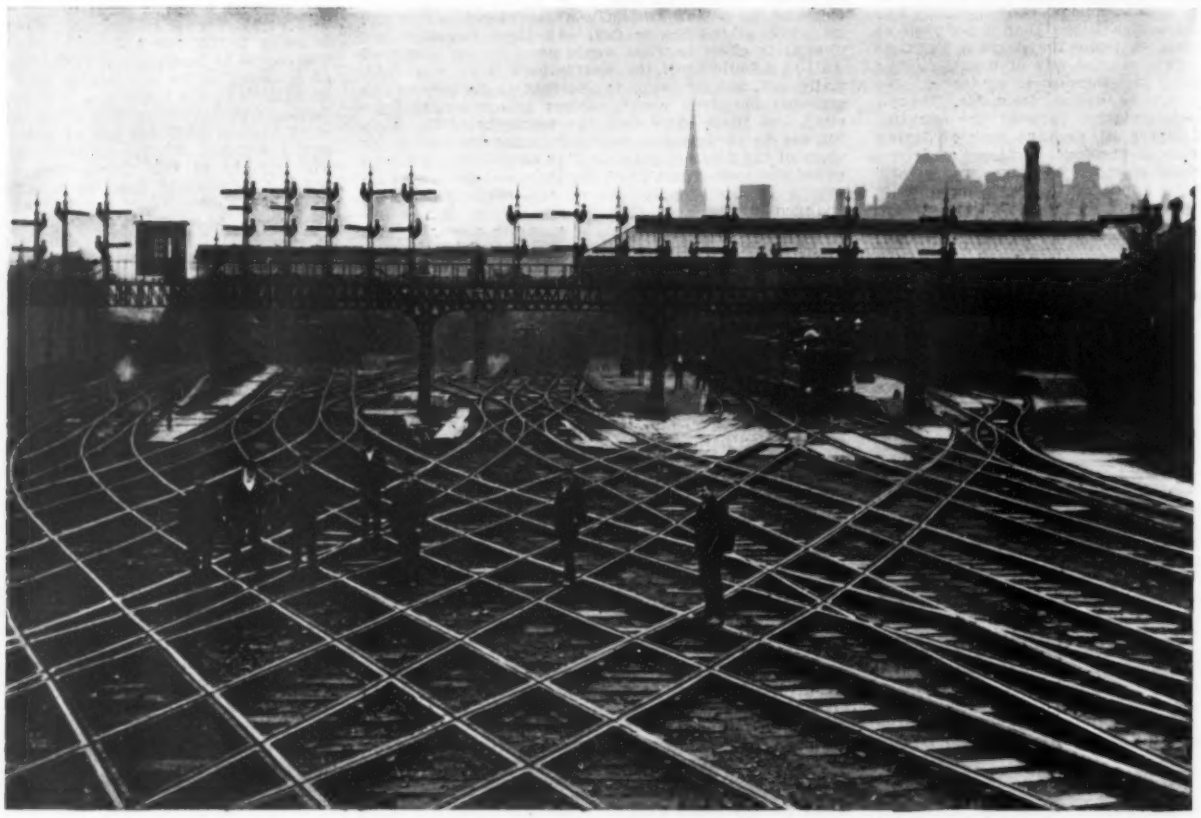
THE SPEAKING ARC.—That the current through the arc is profoundly influenced by aerial vibrations is shown by the successful attempts to use the arc as a telephone receiver. The converse fact, that the arc fed by a continuous current and an alternating current superimposed upon it shows marked fluctuations of intensity, has been shown by E. Koenig. He fed the lamp by a continuous current of 120 volts and an alternating current of 13 volts, making 40 ~ per second. The lamp showed visible fluctuations, with a period of 20 per second. These became stronger on increasing the alternating voltage, without altering their frequency.—P. Weiss, Comptes Rendus, April 22, 1901.

## REMARKABLE RAILWAY CROSSING.

THE accompanying photograph represents one of the most notable railway crossings in the world. It is located immediately outside the Newcastle-on-Tyne Central Railway Station, England. On a day when the regular schedule is being followed, 1,135 trains pass over this extraordinary network of railways, which is used by the passenger, mineral and general freight trains. Of this total 675 trains pass over the High Level Bridge, the tracks which lead to this bridge being those on the extreme left of the picture. The remaining 460 trains pass to and from the district on the east side of the station. The switches are worked from the signal box, shown on the extreme right of the picture, which contains 224 levers. It is operated by a staff of signalmen, worked in three shifts of eight men to each shift, working eight hours at a stretch. The crossing is spanned by a signal bridge which is 155 feet in length; and there is one man for each shift stationed on this bridge. At the end of the station represented in our engraving there are ten platforms.

## RAILWAYS IN JAPAN.

IN Japanese imports of machinery and locomotive and other engines, the United States is surpassed only by Great Britain, which continues to receive more than half the money sent out of Japan for these manufactures, while the United States received a little more than one-fourth in 1900 and a little less than that proportion in 1899. The whole amount paid by Japan for this class of manufactures in 1900 was $5,674,546, about one-fifth being for locomotive engines.



REMARKABLE RAILWAY CROSSING AT NEWCASTLE, ENGLAND.—DAILY TRAFFIC, 1,135 TRAINS.

The railways of Japan are of two classes: Government lines, which, at the close of 1899, amounted to 832¾ miles; and private railways, which at the same date included 2,806 miles. The latter are operated under government charters, which may be permanent or provisional. During 1899, permanent charters were granted for 176½ miles and provisional charters for 261½ miles, showing a decrease in activity of construction of over 66 per cent, as compared with 1898. This falling off in building operations is probably due to the depression prevailing in trade and financial circles, and it is likely that new enterprises will be projected with the easing of the money market. It has been estimated that 7,000 miles of railroad would not suffice for the needs of the country. The following statement, summing up the latest statistics obtainable, shows the situation at the end of 1899:

| | Miles. |
|---|---|
| Government double-track lines | 158 |
| Government single-track lines | 675 |
| Private double-track lines | 92 |
| Private single-track lines | 2,713 |
| Total | 3,638 |

Besides this, there were roads not yet opened for traffic, but for which charters had been obtained, as follows:

| | Miles. |
|---|---|
| Government lines | 1,230 |
| Private lines | 2,483 |
| Total | 3,713 |

For constructing these lines, the government had paid out on lines already opened for traffic 69,679,049 yen, equal to $34,700,166, or an average cost of $41,670.89 per mile. The paid-up capital of the private companies amounted to 173,667,846 yen, or $86,486,587, making an average cost of $30,833 per mile. In March of this year, an additional 17 miles of government railway was opened to the public, this being the first government line in Kiusiu. The government railways are under the direct supervision of the Railway Works Bureau and the Hokkaido Railway Office, while the private railways are controlled by various companies under regulations prescribed by the government. There are 103 of these companies, of which 43 have roads open for traffic, 15 have not entered on practical operations, and 45 have provisional charters only.

The Japanese have taken kindly to the railway, and crowds of people enter and alight from every train coming into the principal stations. The strong feeling of caste which prevails makes it necessary to furnish first, second and third class cars on every train, and the first-class cars are usually subdivided into compartments, making possible a degree of privacy unknown to the ordinary traveler in America; but even the first-class cars are less luxurious in their furnishings than the common cars on most of the poorer roads in the United States. Sleeping cars have been introduced during the past year on the government line between Tokyo and Kobé, and are eagerly patronized and profitable. The charge for a berth is 4 yen ($2), in addition to a first-class ticket. Dining cars are being constructed.

A Japanese expert, Mr. Kyoichi Murakami, who has lately traveled in the leading countries of the world to study their railroad construction and management, is reported to have said that the United States surpassed all other countries in the equipment of its roads in every respect, but he objected to American locomotives because of their greater consumption of coal. America furnishes more than two-thirds of the rails used in Japan, having surpassed in low prices and promptness of delivery both England and Germany, which formerly held this trade.—E. C. Bellows, Consul-General at Yokohama.

## MOND FUEL GAS IN GREAT BRITAIN.

BRITISH commercial and scientific circles are much interested in a discovery made by Dr. Ludwig Mond, of the great chemical firm of Brunner, Mond & Co., Limited, whose headquarters are at Norwich, Cheshire, this consular district. This discovery is a gas for furnaces and gas engines, which, it is claimed, can be supplied to consumers at a maximum price of 2d. (4 cents) per 1,000 cubic feet. Public attention has been drawn to this discovery by the recent application of a number of leading manufacturers in the South Staffordshire district for a bill in Parliament to give the necessary legal authority to erect plants, construct mains, etc., to supply an area of 135 square miles. The bill has been read twice in the House of Commons and has passed through the committee stage successfully, so that the scheme will, in all probability, be in actual operation within the next few years. Five generating stations are to be established, and from these the gas will be conveyed, under pressure in underground pipes, to the various manufacturers in the district for use in furnaces and gas engines, but not for illumination. Mond gas is a "producer gas," made from the cheapest class of small coal and dust, commonly called "bituminous slack." Dr. Mond discovered a process by which this cheap slack can be converted into a clean gaseous fuel in such a way that a very large proportion of the nitrogen of the coal is recovered (as ammonia) and converted into sulphate of ammonia, which is a very valuable manure and fertilizer. The distinguishing features of the Mond process are:

(1) The utilization of cheap bituminous slack.

(2) The recovery of 90 pounds of sulphate of ammonia (value at present, $1.94) for every ton of slack gasified.

(3) Low temperature working, so that no clinkers are formed in the producer, and the ammonia is not destroyed.

(4) Very perfect regeneration of heat by an ingeniously designed system, using water as a heat carrier.

(5) The production of a clean gas of extremely uniform quality, free from tar and grit, and of a higher calorific value than most other producer gases.

Mond gas is not a lighting gas; it burns with a pale-blue flame and has a much lower heating value than illuminating gas. It is a gaseous fuel, adapted for wholesale use as a heating and power agent, and the gas engines at Winnington, Cheshire, using Mond gas, hold the world's record for economy and for long and continuous runs. An experimental open-hearth steel furnace has been worked with excellent results, using Mond gas, and the gas is in daily use for glass melting, ore roasting, many kinds of furnace work, evaporating liquids, heating buildings, etc.

The following technical description of the Mond gas is taken from a paper read by Mr. H. A. Humphrey, M. I. Mech. E., a distinguished expert, at the Institution of Mechanical Engineers in London last winter:

The possibility of using cheap fuel and of recovering its ammonia has been the subject of Dr. Mond's experimental work on gas producers, which was started in 1879 and has been carried out on a large scale for a number of years at Winnington, Cheshire. This work resulted in the solution of the difficult problem of converting the cheap forms of fuel into a good gas of uniform quality in such a way that the ammonia existing in the fuel is not destroyed, but recovered as a by-product. Common bituminous slack, brought by railway wagons into the works, is mechanically handled by elevators and creepers and deposited in hoppers above the producers. From these, it is fed in charges of 8 to 10 cwts. at a time into the producer "bell," where the first heating of the slack takes place, and the products of distillation pass downward into the hot zone of fuel before joining the bulk of the gas leaving the producer. The hot zone destroys the tar and converts it into a fixed gas, and also prepares the slack for its descent into the body of the producer, where it is acted upon by an air blast, which has been saturated with steam at 85° C. (185° F.), and superheated before coming into contact with the fuel. Unlike what is done in other producers, the quantity of steam introduced into the blast is relatively large, and amounts to 2½ tons for every ton of fuel gasified. This large quantity of steam keeps down the working temperature of the producer within such limits as to prevent the formation of clinkers or the destruction of the ammonia, yet permits the fuel to be so thoroughly burned that good ashes are obtained. Half a ton of steam is decomposed in the producer for every ton of fuel burned, yielding thereby free hydrogen to the extent of 29 per cent by volume in the final gas. The hot gas and undecomposed steam leaving the producer pass first through a tubular regenerator in the opposite direction to the incoming blast. An exchange of heat takes place, and the blast is still further heated by passing down the annular space between the two shells of the producer on its way to the fire grate; then the hot products from the producer are further passed through a "washer," which is a large, rectangular, wrought iron chamber with side lutes; and here they meet a water spray thrown up by revolving dashers, which have blades skimming up the surface of the water contained in the washer. The intimate contact thus secured causes the steam and gas to be cooled down to about 90° C. (194° F.), and by the formation of more steam, tending to saturate the gas with water vapor at this temperature, the bulk of the sensible heat is converted into latent; then passing upward through a lead-lined tower, filled with tile to present a large surface, the producer gas meets a downward flow of acid liquor, circulated by

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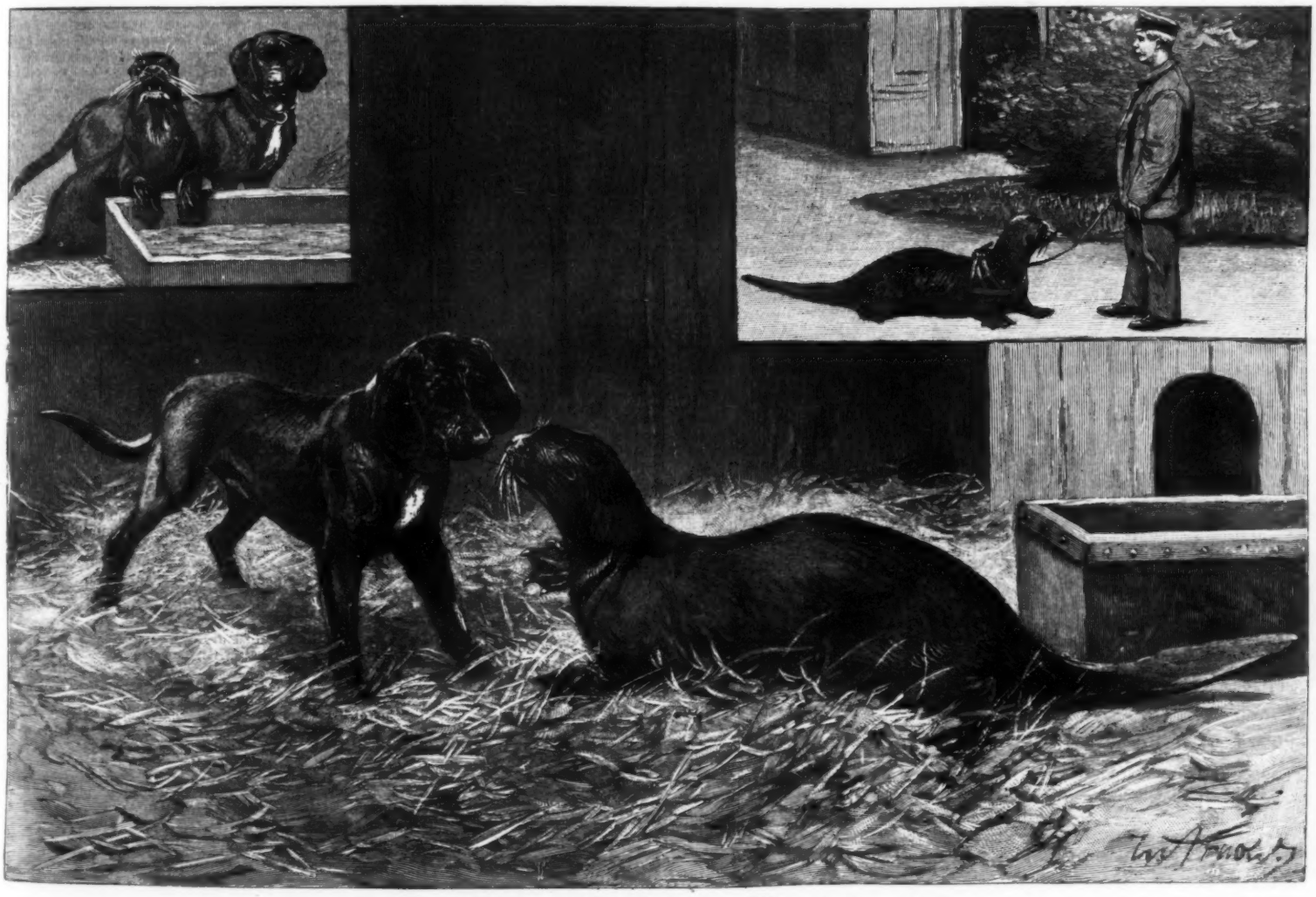
pumps, containing sulphate of ammonia with about 4 per cent excess of free sulphuric acid.

Combination of the ammonia of the gas with the free acid takes place, giving still more sulphate of ammonia, so that to make the process continuous, some sulphate liquor is constantly withdrawn from circulation and evaporated to yield solid sulphate of ammonia, and some free acid is constantly added to the liquor circulating through the tower. The gas, being now freed of its ammonia, is conducted into a gas-cooling tower, where it meets a downward flow of cold water, thus further cooling and cleaning it before it passes to the various furnaces and gas engines in which it is used. The cooling of the gas with its burden of steam results in the condensation of the steam and in raising the temperature of the cooling water, so that the latter leaves the bottom of the tower as hot water, which is utilized in a third tower, caller the "air-heating tower," through which the air blast from the blower is directed. Here, the contact of hot water and cold air gives cold water and hot air, saturated with water vapor at 73° C. (163° F.). By this method of utilizing the heat of the gas from the producer, nearly 1 ton of steam is added to the producer blast for every ton of fuel gasified; and this cyclical exchange of heat is always going on, and forms one of the distinctive features in the economy of the process. The hot water from the gas-cooling tower is circulated through the air-heating tower, and being thereby cooled is again pumped up to the top of the gas-cooling tower. Both towers are filled with tiles, to give large surfaces of contact, and the circulating water acts as the heat carrying agent between the hot gas and the cold air. The charging of the fresh fuel into the top of the producer and the withdrawing of ashes from the bottom in no way interfere with the continuous steady work of the producer. Also, the large volume of steam employed acts as a most perfect regulator in keeping the quality of the gas uniform. Each Mond producer of the ordinary size used at Winnington is capable of gasifying 20 to 24 tons of slack per day of twenty-four hours, and the volume of gas furnished from 1 ton of fuel fed into the producer varies from 140,000 to 160,000 cubic feet, according to the quality of the slack, and is sufficient to develop 2,000 indicated horse power hours when utilized in a gas engine. The value of the sulphate of ammonia recovered from 1 ton of fuel is, at present prices, 8s. ($1.94), naked at the works.—James Boyle, Consul at Liverpool.



THE AMERICAN GIANT OTTER OF THE BERLIN ZOO.

## THE AMERICAN GIANT OTTER IN THE BERLIN ZOOLOGICAL GARDENS.

THE Berlin Zoological Gardens have recently added to the menageries a magnificent specimen of the American sea otter of the genus Pteronura (winged-tail). This scientific term probably originated from the fact that the cross-section of the flat tail presents lateral projections from both sides of the caudal vertebræ. The animal has but two eye incisors on each side of the lower jaw, the one corresponding to the first being constantly absent. The forefeet are very small, and have five short-webbed toes and naked palms. The hind feet, although unlike those of the true otter, approach those of the seal, being large, flat, palmated and furry on both sides. The tail is about one-quarter of the length of the head and body, cylindrical and obtuse in form. From nose to end of tail the animal measures about four feet. The skin is characterized by its looseness. It stretches when removed so as to give the idea of a still larger creature than the otter really is. The fur is beautifully soft and wooly, and of a general deep liver-brown color, silvered or frosted with hoary tips of long, stiff hairs which are, however, removed when the skin is dressed for commercial purposes.

The habitat of the sea otter ranges from the rocky shores of certain parts of the North Pacific Ocean, especially the Aleutian Islands and Alaska, down as far as Oregon. Owing to the great value of the skin, so precious to the furrier, the animal is relentlessly hunted and is gradually disappearing. Unless some restrictive measures are adopted extinction must soon follow, a fate which has overtaken many an animal whose fur is coveted by the followers of Dame Fashion. The destruction of the animal will have wide-reaching effects, which are, perhaps, little suspected. The natives of Alaska who are dependent upon sea-otter hunting as a means of support must starve should the animal become extinct.

The otter in the Berlin Gardens, according to the Illustrirte Zeitung, is quite tame. It has a most curious companion, a dog, with whom it plays. But sometimes the otter wearies of the dog and begins to scream for his keeper. The peculiar piercing shriek which it utters is hardly to be endured. His wild clamoring is usually successful. He is taken out of his cage, and immediately becomes quite tractable.

## FOOD OF SEA LIONS.

THE California State Board of Fish Commissioners during the past two years has taken steps to kill off a very large number of sea lions on the California coast, on the ground that these animals are highly destructive to the salmon fishery. The president of the board, Mr. Alexander T. Vogelsang, claims that it is not the intention of the board to exterminate the sea lions, but merely to kill "10,000 of the 30,000 that now infest our harbor entrance and contiguous territory."* The opinion of observers familiar with the sea lion rookeries is that the number of animals has been greatly exaggerated, and that long before Mr. Vogelsang has killed the contemplated 10,000 there would not be a living sea lion left on the whole coast. Already many have been killed and, unless public sentiment is aroused to check the movement, some of the most interesting rookeries of the State are in danger of depletion. The Fish Commissioners have employed men to shoot the sea lions, and are loud in their lamentations because the government lighthouse reservations have not been thrown open to the slaughter.

The local fishermen, the State Fish Commission and others assert without qualification that the sea lions feed extensively on salmon, and the inference from their statements is that the animals subsist chiefly, if not entirely, on fish. A few years ago, when similar complaints were made against the fur seals, I took the trouble to examine the stomach contents of a large number of these animals, and found to my surprise that the great bulk of their food consisted of squids, hundreds of whose beaks and pens were found in the stomachs, while in only a few instances were any traces of fish discovered.

In 1899, a well-known naturalist, Prof. L. L. Dyche, of the University of Kansas, spent the months of June, July, August and September on the California coast, at a time when the sea lions were being slaughtered in the alleged interests of the fishermen. Prof. Dyche became interested in the question of their food, and took the trouble to examine the stomachs of some 25 sea lions, not one of which contained so much as a trace of fish. The region visited extends from Monterey Bay southward along the coast for about 25 miles.

Between June 25 and July 16 there were washed ashore within three miles of Point Pinos, at the mouth of Monterey Bay, eight sea lions which had been shot, the fishermen said, because they were feeding on salmon. Prof. Dyche examined the stomachs of all of these and has given me a detailed record of the contents of each. It would take too much space to print this in full. Suffice it to state that the remains of squids and cuttlefish (*Octopus*) were found in all, and that several were filled with large pieces of the giant squid. Notwithstanding the fact that at the same time and place salmon were being caught by fishermen, not a fish scale or bone was detected in any of the stomachs. Whenever possible Prof. Dyche opened the stomachs in the presence of the fishermen, who invariably expressed the greatest surprise at the result. On July 20 Prof. Dyche moved his headquarters southward and established a camp about twelve miles below Monterey Bay, between Point Carmel and the lighthouse, near which is an extensive rookery of sea lions. Between July 20 and August 16, the stomachs of seventeen additional sea lions were examined. Eight out of the seventeen were well filled with the flesh of the giant squid; two were gorged with large octopus, while the remaining seven contained pens and beaks of squids, the quantity varying from half a pint to about a quart.

Prof. Dyche was told that there were no fish within two or three miles of the sea lion rookeries near his camp, as the sea lions had caught or driven them away. In the face of this statement, he himself caught a dozen rock cod one morning between shore and the seal rocks, and his boatman, George Carr, an old salmon fisherman, caught plenty of rock cod weighing from one to eight pounds each, within sixty feet of the flat rock where from 1 to 300 sea lions landed each day. The water close to these rocks, where the sea lions had lived for ages, proved to be the best fishing ground in the locality. Prof. Dyche states further that he landed a number of times on the rocky islands where in places the excrement from the sea lions formed a layer a foot thick. He hunted through this for fish bones and scales without being

* In letter to Hon. Lyman J. Gage, Secretary of the Treasury, dated San Francisco, June 3, 1899.

able to discover a single one. On the other hand, the tough pens from the backs of the squids were abundant.

Prof. Dyche found the fishermen loud in their denunciation of the sea lions on account of their alleged destruction of salmon, but, although he was on the fishing grounds continuously for more than three months, the fishermen were unable to show him a single instance in which a sea lion had killed a salmon. He adds: "You can hardly imagine the surprised look on these fishermen's faces when they saw the great masses of squid meat roll out of the sea lions' stomachs when cut open."

The fact that sea lions in captivity will eat fish rather than starve has little bearing on the question, and the additional fact that salmon in nets are sometimes found bitten off or eaten is by itself no evidence at all, particularly in places where either sharks or otters occur.

It is not claimed that sea lions in their native element never eat fish; at the same time the only actual evidence we have on the subject fails utterly to substantiate the allegations of the fishermen. On the contrary, all of the twenty-five stomachs of sea lions examined by Prof. Dyche contained remnants of squids or cuttle fishes, and not one contained so much as the scale or bone of a fish. And is it not significant that in former years, when sea lions were much more plentiful than now, salmon also were vastly more abundant? If the fishermen will look into their own habits and customs during the past twenty-five years it is believed that the cause of decrease of the salmon will not be difficult to find, and this without charging the decrease to the inoffensive sea lions, whose rookeries constitute one of the greatest attractions to the visitor on the California coast.—C. Hart Merriam, in Science.

[Continued from SUPPLEMENT, No. 1330, page 21313.]

## PROGRESS OF PHOTOGRAPHY.*

### REPRODUCTION OF PAINTINGS.

UNTIL a comparatively recent period, photography has failed almost entirely to interpret the colors of nature or art, or to give the proper monochromatic value to them. For instance, yellow and red and all of their combinations would photograph dark, while blue, violet and their shades would develop white. Of late, however, we have what is known as orthochromatic or color sensitive plates, which translate the colors in their proper values as between white and black; or, technically, we have the mono-chromatic scale of colors.

This is of the greatest value, not only for the portrayal of nature, but also for the reproduction of paintings. The art treasures of the National Gallery of London and other great art centers of Europe have been photographed in this manner, and splendid copies have been secured in various European galleries.

Former results in the reproduction of valued works of art were obtained by making huge photographs of the pictures; then skilled artists would restore the lines or modeling. The outcome was a picture in black and white, hence could be copied to smaller sizes with accuracy. It was by this latter method that I reproduced Eastman Johnson's pictures in 1859-1860. "The Old Kentucky Home" was about the first picture which was published by photography—the prints were on albumen paper. As many of them are in existence now we can fairly assert a degree of permanency for that kind of photography.

### PHOTOGRAPHY IN NATURAL COLORS.

Naturally follows the question, Do we expect to reproduce the natural colors? The problem is not yet solved, yet we see announcements and discussions almost every week concerning the discovery at last of "Photographs in the Colors of Nature." This leads the non-expert or layman to believe that the colors of nature are recorded in one operation and the direct image so received is visible to the eye. This is an error. We are not within gunshot of it; no nearer than in the early days of the daguerreotype.

All pictures in color thus far produced through photographic agencies are in a measure optical delusions or color effects. Of all men who have given themselves to the solution of this photo-optical problem Mr. Ives, of Philadelphia, has been the most successful, and in his instrument, which he calls the kromskop, he has produced a scientific toy with which he produces marvelous effects and compels the admiration of the world. For portraiture it is yet unavailable, as the time required for sittings is thus far even longer than the old-fashioned daguerreotype.

In a recent lecture Mr. Ives explained how his process consisted in first making three photographs to represent the effect of the object photographed upon the three fundamental color sensations in accordance with the theory of color-vision now accepted by all scientists, and then combining these photographs by superposition either by projection with a triple magic lantern or in transparent gelatine prints. The three negatives are made from the same point of view by simultaneous and equal exposure and developed together.

Lantern slides are then made from the heliochromic negatives, so that by exactly reversing the light and shade they represent the effect of the object upon the respective color sensations. The triple lantern slide is then projected with a special lantern, each positive with light of the color of the sensation which it represents, in such a manner that the three form a single picture on the screen, reproducing light and shade and color.

It has frequently been announced that persons abroad and in America had discovered the art of reproducing and retaining by photography the colors of nature. Surely nothing in an artistic way could have been more interesting or valuable. Important as was the invention of the daguerreotype and the subsequent development of the art-science of photography, there has always been a desire to see the exquisite tints which we behold in nature, and have in miniature upon the ground glass of the camera reproduced in some tangible and permanent form. Neipce de St. Victor and other French scientists obtained upon the daguerreotype plate some of the colors of foliage, a red brick house, etc., but the range of color was limited and the picture could only be seen in a feeble, non-actinic light, soon fading from view. This was accomplished in the earliest days of the daguerreotype, since which time no material advance has been made in this direction. So far as the art of photography as now practised is concerned, I have no expectation that the development of color will be obtained direct from nature.

In view of the wonderful things that have been given to the world in the line of invention during the last half century, it would be a rash statement to make that the reproduction of colors is impossible. When it comes to us, it will be through the discovery of some entirely new basis or principle in photography, some color sensitive compound entirely away from the present fundamental basis of the art.

Concerning the alleged discovery by an eminent photographer in London, I personally inspected his work at his establishment in London and found his pictures hand painted.

### HISTORIC RECORDS.

W. P. Garrison years ago made a suggestion which I regret I did not act upon. This was to make each year, from the Brooklyn and New Jersey sides, a series of negatives of the sky line of New York city. Last summer I was amazed at the wonderful changes that had taken place in this respect since Mr. Garrison gave me that hint. Truly it seemed as if "every valley had been exalted and every hill made low." The great office and insurance buildings downtown and the colossal apartment structures uptown, mostly erected during the last decade, have so changed the sky line of the metropolis that a good photograph made ten or a dozen years ago would now be of great interest. These changes are constantly going on, and the same value would attach to such pictures taken now and a decade or two hence.

The application of the art to such purposes is no longer new. I, with many others, made a series of photographs illustrating proceedings at the opening of the great Brooklyn Bridge. One of the most important instances of the art's practical utility is the fact that every bit of the territory affected by the construction of the underground railroad was photographed before a spade was put into the ground, and a large corps of photographers are now engaged making a complete record of the work. The many uses to which photography may be put in this direction it is impossible to foresee.

### INSTANTANEOUS PHOTOGRAPHY.

Our wonder is often excited by seeing photographs of waves in motion made so quickly that they are apparently still, and of horses jumping in the air, and by the wonderful biographic pictures now reproduced so successfully. The experts who take these pictures say that they are made in a 250th part of a second, but this is slower than the growth of a pine tree compared to some pictures.

I was consulted in a patent case and the inquiry was made as to whether it was possible to illustrate by photography the following case: One of the claims of the telephone patent is the continuous wire attached to the diaphragm of the speaking tube. This party declared that he could sever that wire and, evading the patent, produce the proper effect.

Wheatstone measured the duration of the electric spark as one twenty-four thousandth of a second. It would follow that any vibration not quicker than this might be arrested on the photographic plate at any points in its travel. Whereas, according to the investigations of Plateau, the duration of successive impressions on the human eye will average half a second, the electric spark might separate and distinguish photographically waves of which 12,000 impinge on the retina while the first of them is still lingering there. Now the vibrations or waves of air that yield the respective tones or pitches of sound have been accurately measured and counted. Assuming the pitch of the ordinary masculine voice in conversation to be as low as middle C, the number of complete double vibrations imparted by such a voice to the telephonic diaphragm or tympanum would be 256 a second; that is, counting both ways, 512 movements of the diaphragm with its metallic point making or breaking the electrical circuit at each movement.

To the eye, which retains every impression for half a second, 256 of these movements would make their impression as one, and would give a stationary, fictitious image, if they were of sufficient depth to produce any visible effect whatever, which they are not. The electric spark, however, would give its illumination and do its photographic work within a little more than one-fiftieth of the time of one of the tympanum movements. A succession of such photographs, therefore, would present fortuitously any position of the vibrating point from that of contact to that of extreme reaction with an indefinite number of intermediate positions.

To verify these calculations I carefully focused the photographic camera on the points of the telephone by daylight, and a battery of Leyden jars was so adjusted that when discharged it would throw the proper illumination on the points. My instantaneous plates were now to be tested under action five hundred times quicker than a sensible instant and also invisibly minute. Of course, it was as yet a practical question whether the photographic plates could effectively receive as quickly as the electric spark would give this infinitesimal action of light.

Waiting until the darkest hour of night, the plate was uncovered in total darkness, the telephonist began speaking into his instrument and the illuminating spark was flashed upon the points. This operation was repeated with more than twenty plates in succession. The resulting negatives, on being developed, proved a triumph in two arts and a science. The photographs printed from them showed under the powerful magnifying glass, in some, contact of the points, and in others a variety of infinitesimally differenced intervals between them. Not one of the impressions had more than the one-twenty-four thousandth of a second in which to be begun and ended.

It would be of but little interest to the lay reader to give dates and formulae of the various steps in the development of the art from the daguerreotype to the present almost perfect methods. It is not amiss, however, to give an idea of the relative rapidities of the various processes: Daguerreotypes (originally), half hour's exposure; calotype, two or three minutes' exposure; collodion, ten seconds' exposure; rapid gelatine emulsion, from one-fifteenth second exposure to the smallest fraction of a second conceivable, as in the patent case mentioned.

### OTHER APPLICATIONS OF PHOTOGRAPHY.

The secrets of the microscope as revealed and recorded by photography are truly wonderful. Many facts in nature and science have been demonstrated which could have been accomplished in no other manner. Experts have secured negatives and excellent photographs of what are known to exist, but which few can resolve by the microscope, to wit, the invisible or white blood corpuscles.

Of late stellar photography has been making wonderful progress. A serious attempt is now being made to secure a complete map of the midnight sky, and there is no doubt of its accomplishment, so far as the sky can be seen from the continents of the globe. At various points of the earth there are observatories where skilled experts are engaged with telescopes especially adapted to the purpose in making photographic negatives of the stellar universe. Millions of stars not before known to exist have been recorded on the delicate sensitive plates.

The carbon photograph is not only a thing of beauty, but truthfully may be declared a joy forever. It is the most permanent of the direct photographic processes, and will, I believe, be as lasting as the printed page. The process is an evolution of the experiments of Mungon Pouton, 1839; of Fox Talbot, 1853, and finally the practical results of Mr. Swan, of Newcastle-on-Tyne, in 1864. It was about 1870 that I introduced it here.

The carbon process is properly named, for the resulting picture is a carbon pigment of almost the same nature as the hieroglyphic writing of the Egyptian papyrus, specimens of which in the Historical Library were written thousands of years ago. Briefly, a sheet of white paper is coated with a solution of bichromatized gelatine in combination with carbon or other pigment. When dried in a dark room it is exposed to the action of light under a photographic negative.

Without describing details of manipulation, the tissue is washed in warm water, when the parts which have been protected from the action of the light dissolve away, leaving portions which have been rendered insoluble by the action of the light in the form of an imperishable image. Processes of more certain manipulation have been more in use than the carbon process, but it will surely have a dominant vogue before long. The difficulties are from the varied hygroscopic conditions of our climate. With us a saturated atmosphere is often followed in a few hours by an absolute absence of all moisture.

### FOR WAR PURPOSES.

Announcement is made in some of the foreign journals that microscopic maps are proposed for war purposes. This was done as long ago as the War of the Rebellion. I then made some experiments in that line for Major Meigs, of the Engineer Corps. Some maps were made by me and were awaiting the examination of Major Meigs when the latter was shot and killed.

Some successful balloon photographs have recently been made, which in actual warfare in South Africa seem to be of the greatest use. A camera was adjusted to the bottom of a car with an exposing apparatus which was operated by an electric wire. Balloons were sent up and upon reaching the limit of the cable by which they were anchored the exposure was made by the electric wire and some excellent topographic maps were secured of the country beneath. In the cases mentioned, small balloons carrying but a few pounds' weight were quite sufficient to accomplish the result. Of course, where practical to send an aeronaut a very complete series of pictures could be made of an enemy's position. These experiments were made by English officers.

### LEGAL EVIDENCE.

As legal evidence photography is growing in constant favor and use. Many times experts have been called to photograph localities where accidents have happened. Some time ago a question of responsibility was settled in court concerning two steamboats which had been in collision. One boat which had received the blow of the other had been at once repaired by the owner, but not until a series of photographs had been made unknown to the owner. At the trial some pretty tall swearing took place, when to the surprise of the witnesses they were put face to face with the art that cannot lie, photography, and the case went against them.

In another case a witness swore that he was turning his horse to the right, when a photograph showed that a deep excavation made it impossible.

In the copying, or, one might say, translation of faded and obscure manuscripts, there have been many novel results. It is known that the camera delineates forms that are invisible to the naked eye. Even the most powerful microscopes fail to reveal hidden mysteries quite within the power of the camera.

A case involving an important sum came up in an Illinois court which puzzled both court and layman. A transfer of property was decided upon. The deed was produced, when it was discovered that the signature of one of the four heirs to the property was apparently omitted. All was soon in a snarl and prolonged litigation seemed inevitable. One party who swore that he had witnessed the signing of the deed was threatened with arrest for perjury. No reason could be given for the omission of the signature and there was much collateral evidence that all four heirs had signed the deed, yet it was apparently not there. At the suggestion of a New York lawyer who had been called into the case, the deed was photographed, when the missing signature appeared on the sensitive plate almost as plain as the others.

In a case which I had for the Hon. William M.

* George G. Rockwood, in the New York Sun.

Evarts I made first a series of small negatives and afterward enlarged them to about 40 inches, showing the traced and amended autographs which were in evidence. No penman can replace the point of his pen on a line without such a fact appearing through photographic agencies; neither can he change ink without such fact being detected.

One would naturally ask, "Can the camera see better than the human eye?" In many ways photography has the best of it. In fine distinctness of color the sensitive film will often determine questions where the human expert fails. In old faded manuscripts, in which many letters and words are not legible from the close approximation of the color of the paper to the faded ink, the photograph will often define the characters and unravel the mystery of time and bad chirography. Many other important legal cases have of late years been decided by this means.

PHOTOGRAPHY'S PLACE.

My space is too limited to do more than mention a few of the many applications of photography to the arts. To sum up, it is used in portraiture, architecture, illustration, reproduction, criminology, astronomy, decoration, relief work, records, glass staining, pathology, and other ways in a larger degree in exact science and the useful arts than in its æsthetic application. It has created a new and mighty industry which will continually extend, as new fields and applications are constantly opening. It has lessened the cost of books marvelously and thus become a great educator. It has created what might properly be called a mighty kindergarten system of object lessons. By it our children have been made as familiar with scenes of interest in all parts of the world as old travelers. It brings to them and us noted people, objects of historic and artistic value and records of events. School children will identify a view of the Coliseum of Rome as promptly as one taken of the Aquarium at the Battery. Thus it is a great educator, and I can close as I began by describing it as one of the great trinity of forces in the present era, electricity, steam and photography.

## ELECTROLYSIS OF WATER AND GAS PIPES.*

By W. W. BRIGDEN, Engineer and Superintendent, Water Works, Battle Creek, Mich.

THE electric current is made or generated at the power house; it then passes overhead along the feed wires, which connect with the trolley wire, thence along the trolley wire to the car, down the trolley pole, through wires connected therewith to the motors, where considerable electro-motive force or power in the current is expended in propelling the car. The current then passes through further wiring and metal portions of the cars to the wheels, and from the wheels to the rails. The amount or volume of current is still the same; that is, there is the same number of amperes, but the pressure or voltage is greatly reduced by the motors. The current then follows the rails to the point nearest the power house and is carried on wires from the rails to the other side of the dynamo from which it started. In the double trolley system the same process takes place except that there is another pole and another trolley wire alongside of the one which carries the current outward from the power house, and this second trolley wire takes the current back to the generator or dynamo. In the case of the double trolley the current does not get upon the rails or into the ground, water pipes, gas pipes, etc., but is returned to the power house by wires suspended in the air, as is the case with electric light and other similar wires. The process of electrolysis is often quite similar to that of electroplating, although the path of the electric current is not so well arranged for doing the work in the case of the street railway current as is that of the electroplating machine. The current in the case of the street railway is only able to carry the material subjected to electrolysis a short distance away from its source, but is frequently powerful enough to make a heavy deposit on stones, sand and other similar materials at a distance of from one to three inches from the pipe.

Our own home story is always the easiest one to tell, and while it is not nearly so interesting as that of many other places, still it has some points of peculiar interest that may not have come to the attention of any of those present. The city of Battle Creek was one of the first small cities in Michigan to grant a franchise to an electric street railway company. They granted a gentleman a franchise, who shipped in a lot of second-hand flat rails from Cleveland, Ohio, and the balance of his material for construction was very little better. The rails were bonded with iron telegraph wires about one-eighth of an inch in diameter. The trolley wire was small and the cars did not begin to compare with those of to-day. The original management operated the road for a year or two and then sold out to another party. By the statement of its own employes the company was losing fully one-third of its current in forcing it over the miserable conductors it used. All the wrought iron and lead gas and water pipes in and near the power house were completely destroyed, and the eight-inch water main received considerable injury. The writer has failed to learn of more than one street railway as poorly constructed as this one.

The present street railway line was constructed by a much better class of men, and while they did not provide for the taking care of their electric currents so well as is done at the present day, the construction was fairly good for the year of 1895. Sixty pound tee rails were used and most of the rails were bonded with two No. 0 copper wires at each joint. Experience with the old company led the officers to be on the lookout for damage from electrolysis, and when there was a leak in the water service about five hundred feet from the power house the superintendent made an examination and determined that it was occasioned by electrolysis. There was afterward a large leak under the floor of the power house. The water from this leak did not pass through the meter upon the premises, but as it was a clear case of electrolysis, a bill was sent to the electric light company, who furnished the railway power, for the estimated amount of water wasted, and the bill was paid. The four-inch water main on the street near the power house was so much injured in about four years that it could be cut in many places to the depth of one-sixteenth of an inch.

Many cities have employed expert electricians to make examinations of the damage that may have occurred from the return currents of the electric railways, and almost without exception some damage has been discovered to water pipes, gas pipes, lead conduits or other similar metallic substances. Battle Creek employed Mr. E. E. Brownell, of Dayton, Ohio. He reported much less damage than in other places, but that there were differences in electric pressure between the water pipes and gas pipes on one hand and the rails on the other hand that would bring about the destruction of the service pipes, water mains and gas pipes within a very few years. The gas company joined with the city in having the electrical examination made and will also assist in any legal proceedings that may be undertaken. No electrical readings were taken at the original examination as to the want of conductivity at rail joints, but since then the superintendent has taken a large number of such readings and has in several cases found at steam railway crossings, etc., places where the drop or difference in pressure would be at times as high as five to eight volts, which means that there was an open circuit, or about such a condition of affairs as would result if a wire was lying on the ground and should be cut in two, leaving the two ends very near each other but not touching. The street railway company is now making a very full and careful examination of rail joints and other places where electrical deficiencies may be found and its experts will soon send in a report. Readings have been taken near where the return wires leave the track and are carried to the new power house, placing one wire in the bottom of a large mill race or canal and the other on the rails, and readings obtained for a few seconds as high as six or seven volts, which shows that a large percentage of the return current was coming back to the power house along the water main which runs under the bed of the stream and along the bottom of the canal which is connected with both the Kalamazoo River and its tributary, Battle Creek.

Quite strong electric currents have been found passing along the rails of steam railroads having such irregular and varied directions and pressures that nothing but a complete electrical survey of the entire surrounding district would enable one to have a clear idea of the exact cause of their divergence. Currents have been found that passed directly away from the power house, then were deflected along water mains until they reached a point a mile out of what seemed the proper course for their return, when they suddenly took a somewhat more direct course to their final destination. In several places distant from the power house, where the mains were large, readings taken from the hydrants to the rails, when cars were near and load was heavy, showed strong currents passing from the rails to the hydrants, which indicated that the current was not getting an easy path on its return by the rail, and in all probability the water mains were receiving small amounts of current at almost every length of pipe, the aggregate of which in a mile or two would be considerable. In Detroit the rope or yarn used for making the joints of a portion of a main that had been cut was set on fire by the passage of the current across the gap left when the pipe was about to be jointed.

Our electrical street railway friends began bonding their rails with an iron wire one-eighth of an inch in diameter. After they found that this would not work it was increased to ¼ inch diameter and made of copper; then to 1-3 inch diameter; then two of the last named bonds were used, and now the better roads are bonded with two copper bonds about ½ inch diameter, or with stranded wires or flattened strips of copper of an aggregate section equal to ½ inch diameter. Bonds are made and have been in use for years that have an electrical carrying capacity nearly or quite up to that of the full section of a 70-pound rail; but these are still given the cold shoulder by nearly all of the street railway companies, and probably none of them are in use in any but the largest systems. Yet, it is asserted by some of the best electricians in the country, and is believed by the writer, that such a bond as this, which would be equal to a piece of solid copper rod about one inch in diameter, would not prevent the return currents of a moderate-sized street railway system from having an undesirable portion diverted to other conductors than the rails. In other words, if the average street railway in a moderate-sized city could have its rails all welded together the current would still escape to water and gas mains.

The use of larger and better constructed rail bonds, and the addition of bare supplementary wires laid between the rails and connected, say, every 200 feet, or insulator wires carried alongside the track on poles and connected with the rails every 300 or 500 feet, would greatly improve many of the returns of street railway currents at the present time. Even the running of overhead wires connected to the track in but few places where there was more than the usual lack of returning capacity, would be of value. This has been done in Grand Rapids, Mich., using ten return wires, and is quite successful. But when we understand that there is from one to two hundred up to thousands of amperes of current used by the lines now operated, and that one ampere will destroy 25 pounds of iron, or 75 pounds of lead in a year, and that in many places the rails are returning but 10 to 30 per cent of their total output, it is easily seen what fearful havoc may be brought about.

Of one thing we may rest assured, better return conductors must be devised, or the great increase in the number and weight of cars will soon make the operation of a single trolley street railway an unbearable nuisance.

If we are to believe the electrical engineers having the greatest experience in investigations of electrolysis, we must accept as a fact their statement that the double trolley system, or an underground system in conduits, well insulated, is the only complete cure known for electrolysis. To be sure, a great improvement can be made in many street railway lines by careful and frequent examinations of all joints and rails and a correction at those places found deficient, and this may be sought as the only available remedy at present.

It is doubtful whether there is any economy in the construction and operation of a single trolley line as against the double trolley except in the matter of original cost, and there the difference does not exceed $1,000 per mile. In fact, if the rails are bonded to the extent that the best authorities recommend, the chances are that the cost would be fully as great for the single trolley as for the double trolley. No bonds are of any use where the double trolley system is adopted. The Cincinnati street railway lines have two hundred miles of track, and their management says that the original system of double trolley line has been so satisfactory that several single trolley lines, which have been purchased and added to the system, have been changed to the double trolley and the company is satisfied that there is an economical saving over the single trolley in their expenditures for maintenance. All new street railways in the suburbs of Washington, D. C., are required to put in the double overhead trolley system, and in the central portions of the city the conducting wires are required to be placed in underground conduits carefully made and with the wires well insulated.

It is the belief of excellent authorities on water works construction and maintenance that the life of a water pipe in the average soil will be at least doubled or trebled by the addition of a coating of coal tar pitch or similar preparation put on at a high temperature. A 6-inch gas pipe in Battle Creek which has been in use for thirty years shows no sign of rust on its exterior surface, and there seems no reason why a water main should not last equally as well. Where electrolysis takes place, even to a moderate extent, this coating is so far destroyed that it loses nearly or quite all of its value as a preservative. It takes but a very small portion of the current of a street railway to injure this coating. If the water pipe is near the rail it might readily be done with a difference in potential not exceeding one-fourth volt. No water system in the United States has received so great injury as that of Dayton, Ohio, where over two miles of water main besides many services have been so badly injured as to probably require their speedy removal. This city has brought suit against the street railway company for $70,000, and since the filing of the original suit has added several thousand dollars to the original bill. The natural gas company of Indianapolis, Ind., began a suit against the street railway company, which has greatly injured their piping system. The local court decided that a remedy was available to the street railway company, but no remedy was available to the gas company, therefore, the street railway company was liable for damages and must apply the proper remedies or pay the same. The suit was for $50,000 damages, and the natural gas company seemed to have proved that damage had actually taken place, but the street railway company still held that it was not liable. The case was carried up to the Superior Court, the street railway company demurring to the ruling of the lower court. Judge Carter, of the Superior Court, overruled demurrer and practically decided that damages must be paid. It is thought that the street railway company will appeal to the Supreme Court of the State. If it does, let us hope that an early decision will be rendered. The water company of Indianapolis is also preparing to bring suit against the street railway company, and it is claimed that great damage has taken place. The officers of the company are unable to state how much, as it would require an expensive examination to even approximate the amount. Suit has been brought by the Peoria, Ill., water company against the street railway company in that city asking for an injunction to restrain the street railway company from allowing its currents to get upon the ground in any manner.

Franklin, Ohio, where great damage has been done to all pipes on one side of the river by a suburban line passing lengthwise through the town, has begun suit and expects soon to bring the case to trial. The Spokane Falls Gas Light Company brought suit some time ago against the Spokane Street Railway Company. It was decided by the county court that the street railway company must within six months apply either cast iron welded joints or Chicago bonds to various parts of its line. It was contended by the gas company that the double trolley system should be adopted as that was the only known means of preventing stray currents from getting on gas pipes. The street railway company, of course, did not want to be compelled to do anything. The decision seemed to have been in the nature of a compromise between these views, and was so unsatisfactory to the gas company that, although it had practically won the suit an appeal was taken to the Supreme Court, but no hearing has yet been had before that court. In the meantime most of the experts who had examined the welded joints have decided that while it is a good mechanical appliance for carrying the car wheels over joints it is anything but a success as an electrical conductor. The Chicago bond, which is a bundle of small wires with an annular terminal or end piece made to fit in a hole bored near the end of the rail, through which a pin is driven which expands it to the full size of the hole, has been partially displaced by similar forms of bonds with a solid and longer terminal which is expanded by a strong hand power machine made for the purpose. Several suits have been started and are under way in other cities and in a few places street railway companies have paid moderate sums for damages produced by electrolysis. The apathy with which municipal officers especially act, who would otherwise have great influence in compelling a proper decision, is greatly to be regretted. It is partially with a view to correcting this evil that agitation on this subject should be kept up by all those who desire a proper solution of the problem.

The damage to gas mains is still greater than to water mains, because the perforation of the gas pipes produces leakage, which, passing into the basement of the buildings is ignited, and an explosion takes place that in several places has wrecked the buildings.

* Read before the Michigan Engineering Society.—From Municipal Engineering.

The question is frequently asked what legal action shall be taken by legislative bodies in order that there shall be at least a lessening of the injuries due to electrolysis in the future. The question is easily asked, but a law that can be practically carried out is not easily devised.

It is said that several State Legislatures will have before them during this winter's session, for passage, bills providing for exemption from damages due to electrolysis.

Battle Creek has passed an ordinance which is more full and complete than any the writer has seen. The main points of the ordinance are that all new lines shall be provided with a double trolley, and that should any line be allowed by law to use the single trolley system it shall be required to put in a very complete and expensive bonding. It is believed that a street railway company could put in a double trolley system at least as cheap, if not cheaper, than it could comply with the bonding required by this ordinance. It was not expected that the bonding as set forth in the ordinance would be strictly followed, but if the single trolley system should be allowed, the best known bonding at the time could be secured in lieu of that required by the ordinance. This ordinance also fixes the maximum difference in potential or voltage that may occur at any time between the gas pipes, water pipes and other similar substances on the one hand, and street railway track on the other hand at one-fourth volt. This is a very close restriction for a single trolley railway, there being in Battle Creek occasionally momentary readings of five to eight volts, and several places where the average would reach two to four volts in the summer time, when the travel is heaviest.

In many cities there is a difference of voltage, or pressure, as high as twenty or thirty volts, and there are some cases where it has largely exceeded these figures. The ordinance also requires all street railway companies to make full and complete electrical examination of their return conductors every six months and furnish copies of the results to the proper city officials. In case the examination shows deficient conductivity it is required to be made good within three months of the date of examination. The best and most modern devices for conveying electricity are required to be installed and used. Street railway companies are made responsible for damages, and proper penalties are attached for failure to comply with the conditions of the ordinance.

There are 18,000 miles of electric railway and 50,000 cars in the United States, which is nine times that of the year 1900.

It is the opinion of the writer that almost every small town in Michigan will, in a few years, have its electric street railway lines, and should there be no improvement made so that some other and better means of transportation—such as the automobile may possibly become—is devised, the State will be gridironed with these lines within the next ten years. Municipalities and water and gas companies should, therefore, do the utmost possible to reach the proper remedy for the evils due to electrolysis soon, and should then place on the statute books such legislation as will bring about a complete change in the present methods of returning the currents of street railways. In Fort Wayne, Ind., 1,000 feet of 12-inch water mains was removed because of the damage done from electrolysis. It has not been stated publicly what the damage aggregated, but if on a well-paved street it certainly could not be less than four or five thousand dollars, supposing that the service pipes were also injured, which is more than probable. There are not less than seventy cities which have publicly stated that the damage had been done by electrolysis, and at least one prominent electrical engineer affirms that in his opinion there is not a single city where the single trolley system is in use that damage has not taken place.

In reply to a circular letter sent out by the writer to thirty-five cities, replies were received from fourteen. Several had not even investigated the matter of electrolysis. Five or six had given the matter most serious attention—most of them having had examinations made by experts. These nearly all report damages to either water or gas pipes, in some cases the damage being almost entirely confined to one set of pipes. The superintendent of the water works of Cincinnati reports no damage since all of the lines in the city have been put under the double trolley system. He seems so confident of safety that he has given the matter but little attention for several years past, although no doubt called upon to give his opinion as to the value of the system as used in his city. He reports serious damage on a single trolley line that has lately been changed to a double trolley.

Nearly all report no legal action either past or contemplated, although four or five have some provision in the franchise granted the street railway company by which it would be partly or wholly responsible for the injury done pipe systems. Some have tried to get ordinances passed and failed. Only three reported having been paid for damage done, although three others had presented bills, which were refused payment. Several were only seeking exemption from future damage and would be glad to let the past go if that was accomplished. Several stated that they would join with other cities and water and gas companies to procure legislation prohibiting street railways from returning their current in water and gas pipes, while others were doubtful as to their authority to agree that this should be done, but otherwise appeared willing. To the question as to whether the street car company had negotiated with water works and gas companies in a spirit of fairness and with readiness to do those things that would bring about better results, the replies of several indicate no negotiations with the street railway company, or no necessity of any. One replied that the negotiations were all that could be expected; that they were entirely fair. Peoria, Ill., reports that the water company offered to pay one-half the cost of the change from single to double trolley, up to $10,000, for its half, and to waive all claims for past damages. This offer was rejected, so suit was brought. One reports that he has not and never will negotiate with the street railway company. In this same city the gas company has brought suit for $50,000 damages, and the water company is preparing to take similar action. Judging from the information that is available to the writer, about one-half the street railway companies meet the water and gas companies in a spirit of fairness and with at least some attempt to remedy the evils complained of, while the other half resist with more or less tenacity every attempt to bring about a better condition of affairs on the part of those injured, and in some cases go so far as to utterly ignore every attempt that the water works or gas companies can devise to collect damages for past injuries or to protect themselves in the future.

## THE USE OF OXYGEN IN BALLOON ASCENSIONS.

THE action of oxygen upon the organism submitted to pressures lower than that of the atmosphere has been made known through the researches of several physiologists, particularly those of M. Paul Bert. It

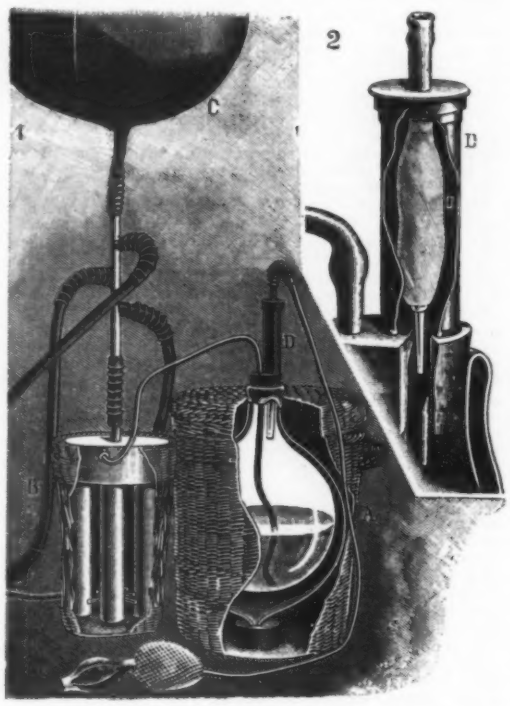



FIG. 1.—1. GENERAL VIEW OF OXYGEN APPARATUS. 2. VALVE ON LIQUID OXYGEN RESERVOIR.

has been found that the dangers inherent to a diminution of the atmospheric pressure might be efficaciously prevented by the respiration of pure oxygen, or rather of air enriched with oxygen, so as to keep the quantity of oxygen absorbed at every inspiration nearly constant.

This discovery was, as soon as it was made known, immediately practically applied by aeronauts, and, at the time of the ascension of the "Zenith" in 1875, M. Paul Bert furnished the balloonists with small receptacles filled with the gas. Was it the insufficiency of the volume of the oxygen carried, or was it the defective process employed for inhaling it that led to the fearful catastrophe that is yet present in the memory of every one? We shall probably never know. Since that epoch, the method of using oxygen in balloons has undergone few improvements. The gas is always carried in rubber bags, or, what is preferable, in steel cylinders, under a strong pressure. After the aeronauts have reached a height of several thousand feet, and the first symptoms of asphyxia appear, they open the oxygen reservoir, and, by means of a flexible tube provided with a mouthpiece placed between the lips, aspire the gas. Such a mode of absorption is absolutely defective. It is our custom to breathe in air through the nose, and, if we desire to change this inveterate habit, we shall have to exercise a strength of will and constant attention that it is very difficult to impose upon aeronauts in the state of moral and physical depression experienced in high regions. Oxygen respired by means of the mouthpiece enters the buccal cavity merely, without reaching the lungs.

The quantity of oxygen placed at the disposal of aeronauts up to the present has always been quite small. It occurred to M. Cailletet that the oxygen that he succeeded in liquefying, and that can now be obtained industrially in this state, would permit of carrying in small bulk a quantity of oxygen that would exceed the needs of aeronauts. In fact, one quart of liquid oxygen weighs about two and two-fifths pounds. Upon resuming its gaseous state, this quantity of liquid oxygen gives about 48,000 cubic inches.

Liquid oxygen may be easily preserved in glass vessels with double walls, between which is formed an absolute vacuum. It can be kept in this way for about fifteen days at the pressure of the atmosphere.

These receptacles, which are easily carried, are due to Prof. d'Arsonval, who made them known as long ago as 1888 under the name of "thermo-isolating reservoirs." It would be easy to replace these vessels by metallic receptacles, the construction of which M. Cailletet has now under study.

As the temperature of liquid oxygen preserved at the pressure of the atmosphere is about 200° C. below zero, it suffices to pour it into any sort of vessel at the surrounding temperature in order to have it enter into ebullition and rapidly resume the gaseous state.

The apparatus constructed by M. Cailletet for the use of aeronauts consists of a double-walled glass bottle (Fig. 1, No. 1 *A*) containing liquid oxygen and closed by a stopper through which pass two tubes. One of these tubes ends above the level of the liquid, and is provided externally with a rubber bulb, by means of which a pressure of air may be exerted upon the liquefied gas. A second tube of lead of small diameter traverses the stopper and descends to the bottom of the liquid, while its other extremity, which is threaded, is adapted to the vaporizer, *B*, a sort of tubular boiler of small size and very light, formed of seven communicating copper tubes. By reason of the great heat conductivity of the copper, the liquid oxygen that is introduced by acting upon the bulb quickly resumes the gaseous state and enters a cylindrical rubber reservoir, *C*, secured to some part or other of the balloon. It is in this supply of about 4,270 cubic inches of oxygen that ends the flexible tube through which the gas reaches the aspiration apparatus.

This apparatus is a sort of metal mask (Fig. 2) covered externally with velvet in order to protect it against cooling. It covers only the nose and mouth and is held against the face by means of elastic bands. The oxygen coming from the rubber bag enters the mask through a flexible tube properly adjusted once for all.

The absorption of the gas is therefore assured, and the oxygen is obliged to enter the lungs.

A small quantity of liquid oxygen contained in the receptacle (Fig. 1, *A*) tends to resume the gaseous state, especially when the balloon ascends. The pressure that is then exerted in the interior of the receptacle causes the passage into the vaporizer of a variable quantity of liquid oxygen, which is thus lost. In order to prevent such an accident, M. Cailletet has arranged (Fig. 1, Nos. 1 and 2, *D*) a copper tube 0.6 of an inch in diameter, in the interior of which is placed a thin rubber bag communicating at the upper part with the entrance of air injected by the rubber bulb and terminating beneath in a copper ajutage of small diameter. In an inoperative state, the oxygen that resumes the gaseous form escapes into the atmosphere through the aperture, *O*, but as soon as the bulb is acted upon in order to exert a pressure above the liquid oxygen, the rubber bag, by reason of the difference in diameter of the admission and exhaust air orifices, expands, and, applying itself against the aperture, *O*, closes it completely.

Almost all the aeronauts who have respired pure oxygen assert that it causes nausea. In order to ascertain whether this was really the case, M. Cailletet, in conjunction with Prof. Grehant, instituted a series of experiments at the Museum of Natural History and found that dogs upon breathing pure oxygen experienced a very pronounced uneasiness. Their efforts to

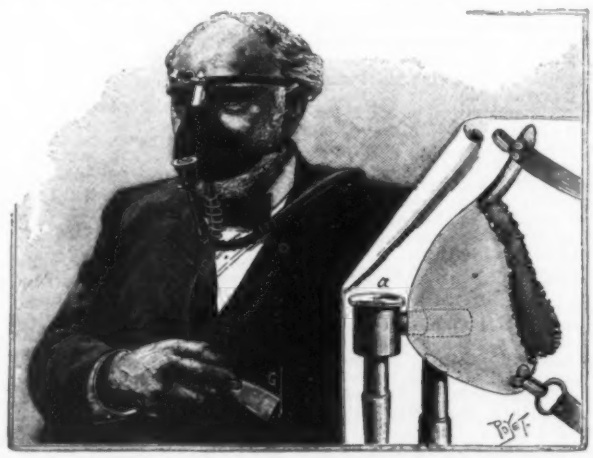



FIG. 2.—ARRANGEMENT OF THE MASK UPON THE FACE.
(Details of the Mask in the Cartouche.)

free themselves from the inspiration apparatus were a proof of the constraint that they experienced; but this painful state ceased as soon as a certain proportion of air was mixed with the inspired gas.

Taking these observations as a basis, M. Cailletet has arranged the mask in such a way as to permit of respiring pure oxygen or a mixture of oxygen and air at will. To this effect, a movable piece provided with a slit (Fig. 2, *a*) that may be opened more or less, permits the external air to enter in easily regulated quantities; and it is this mixture that reaches the lungs. As for the gases due to respiration, in order to prevent the condensation of the aqueous vapor that they

carry along, they are made to pass through a flexible tube, *G*, provided with a special valve placed under the clothing of the aeronaut, so that no congelation shall occur. Upon the whole, M. Cailletet, in constructing this apparatus, has endeavored to render it as simple as possible, so that its operation shall give no trouble to the aeronaut, who, when he sees the rubber bag becoming empty, will merely have to act upon the bulb in order to cause a new quantity of liquid oxygen to pass into the vaporizer.

The aeronauts will have to begin by inhaling oxygen as soon as they have reached an altitude of 13,000 feet, and not wait until the first symptoms of asphyxia exhibit themselves.

This apparatus has just been tried in an international ascension made by Count Castillon de Saint Victor, the well-known aeronaut. For this experiment, it was necessary to employ oxygen compressed in a metal cylinder, since it was impossible to obtain liquid oxygen at the time of starting.

The balloon "Eros," of 73,500 cubic feet capacity, inflated with illuminating gas, and manned by three aeronauts, ascended from the Landy works on Friday, April 19, at 8.50 A. M., and landed at 1.45 P. M. in the department of Eure-et-Loir.

In a letter addressed to M. Cailletet by Count Castillon, he says: "Upon reaching an altitude of 14,430 feet, the temperature being —5°, I put on the Cailletet mask, while my two companions respired oxygen with a simple tube provided with a mouthpiece placed between the lips. When we reached a height of 17,056 feet, my companions began to feel a slight oppression. At 18,040 feet, one of them was about ready to faint, and I had to give up the idea of ascending higher. I kept the mask upon my face for nearly two hours, and, owing to the arrangement of the apparatus, I respired for the whole of that time oxygen mixed with a certain proportion of air, and did not experience the least trouble, while my companions suffered more or less." —For the above particulars and the engravings, we are indebted to La Nature.

## THE DAME, POTTEVIN AND PIAT PASTEURIZING FILTERS.

AFTER long and minute researches, MM. Dame (chemist), Pottevin (doctor of sciences) and Piat (engineer) have obtained the most satisfactory results in the perfect filtration of water, by means of an apparatus that we shall describe.

The filter, properly so called, consists of a disk of hemp and flax cellulose mixed with infusorial earth, in definite proportions, regulated according to the pressure of the water that is to traverse it. This intimate mixture is effected in a special mill. After coming from this, the product is placed in moulds that give it the form of cakes about 8-100 of an inch in thickness and from 6½ to 8¾ inches in diameter, according to the apparatus. The cellulose is not compressed in the moulds, but is simply held by a disk controlled by a screw, and hand wheel, so that the mould may be easily fitted in order to drain off the water that it contains.

The cakes thus obtained have a diameter greater than that just indicated, which is that which they possess definitely. They are carried, held between perforated disks of rubber, to a stove wherein they are submitted for two weeks to a progressive temperature reaching 40 degrees C. Under such circumstances the desiccation takes place slowly, and not suddenly, as would be the case were the water expelled by a strong pressure. The result is a greater density and smaller and more uniform pores. As the shrinkage takes place in the direction of the radii, after their stay in the stove, the disks preserve their form, and the waste due to cutting is insignificant.

As will be seen further along, the apparatus have no joints, these being compensated for by applying to the circumference of the disk an impermeable layer of paraffine. To this effect, the disks are arranged alongside of one another in a drum having a slow rotary motion, and enter a reservoir beneath into which the liquid, previously heated to a determinate temperature, fails regularly so as to keep the level constant.

The disks are afterward inclosed in paper envelopes hermetically closed and secured with a special glue capable of supporting quite a high temperature without melting. The envelopes containing the disks are, with a view to sterilizing them, then placed in a small stove, in which they are heated for half an hour at a temperature of 180 degrees C.

The operation finished, the envelopes are put upon the market.

All the manipulations extend to several "series" of disks at a time, and we should omit one of the most essential parts of the manufacture did we neglect to mention the trial of the products.

No series of disks is delivered for use until after it has been submitted to genuine laboratory tests in order to ascertain its efficacy according to the pressure that it will have to withstand.

To this effect 6 cubic inches of sterilized bouillon of peptone are taken, and 6 cubic inches of water running from the filter under experiment are allowed to fall into it. If the bouillon remains clear, it is because the water itself is sterilized; if it were not, a precipitate would form. In this case, the disks are condemned. Let us say, incidentally, that the composition of the disks is such that whatever be the pressure of the water, it takes a minute to traverse them.

The filter consists of two caps provided internally with grooves, and between which the water passes. In one of them ends the supply pipe, and in the other, the pipe that carries off the filtered water. The cellulose disk is secured between them through the intermedium of two tinned or silver-plated bronze disks forming a network with very small meshes, and serving to prevent distortions of the cellulose disk. The function of the caps is effected by nuts mounted upon threaded rods capable of oscillating around an axis passing through lugs cast in a piece with one of the caps; the other cap being provided with corresponding lugs, against which bear the projections of the nuts.

With certain pressures, the apparatus is capable of discharging 20 gallons every 24 hours. When there is no pressure, the discharge is about a quart an hour.

Whatever be the purpose for which they are designed, all the Dame, Pottevin and Piat filters have the same arrangement, and differ only in some details of construction and in the number of the elements juxtaposed. Fig. 3 represents a sterilizer of eight elements. The water to be filtered enters this through rings provided with mud cocks at their upper part, and makes its exit, filtered, through the other rings as well as through the caps at the extremities.

Between each ring may be distinguished the filtering disk and the two disks with fine meshes. The dimensions of the current apparatus are as follows:

| | Length. | Width. | Height. |
|---|---|---|---|
| 4 element apparatus | 16 inches | 14 inches | 16 inches |
| 8 " " | 20 " | 14 " | 16 " |
| 14 " " | 26 " | 14 " | 16 " |

Under heads of from 25 to 33 feet their discharges are respectively 168, 335 and 588 gallons per 24 hours. With heads of 65 feet the discharge reaches 288, 576 and 1,000 gallons.

For the above particulars and the engravings we are indebted to La Revue Technique.

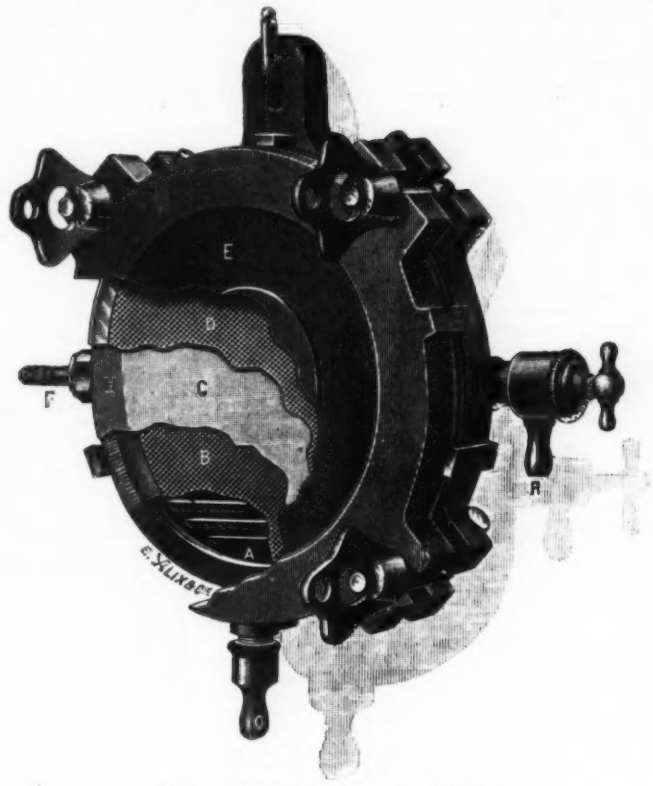



FIG. 1.—PASTEURIZING FILTER.

*A*, cap receiving the water to be filtered; *B* and *D*, grills; *C*, filtering disk; *F*, inlet pipe; *R*, mud cock; *O*, exit of filtered water; *H*, impermeable coating.

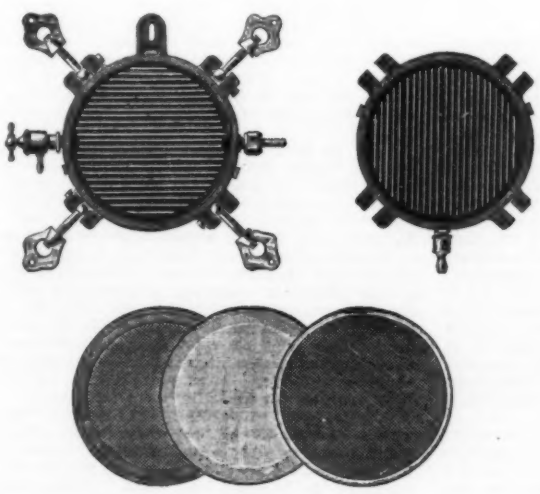


FIG. 2.—DISKS.

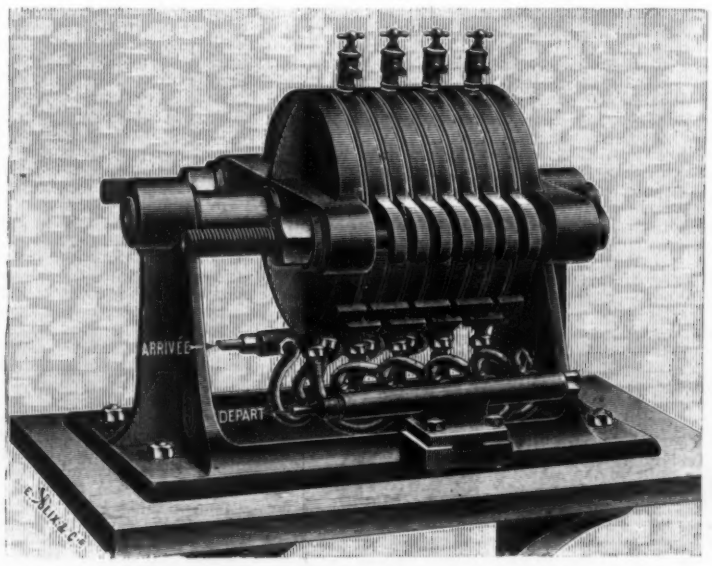



FIG. 3.—STERILIZER OF EIGHT ELEMENTS.

## MILK CONTAMINATION AND HOW BEST TO PREVENT IT.

By D. S. HANSON, M.D., Cleveland, Ohio.

IN order to fully appreciate the painstaking work necessary to prevent milk contamination, it is requisite that all the details of its production and transportation be thoroughly understood, as well as the element of time taken in handling it, taken into consideration, for it is well known that milk of a very good quality soon deteriorates even where the most perfect practical methods are used for its preservation.

I say practical methods, for milk can be kept sterile for a considerable length of time (probably several months), but details necessary are such that milk for general consumption cannot be distributed in that condition. This subject has been discussed by medical societies, boards of health, etc., very widely. No doubt the agitation of the subject has done much good, yet only to a very limited extent has anything of a true practical nature been accomplished. The

immensity of the business (the estimated number of cows in the United States being 5,500,000) would warrant much more attention than it has received.

The subject may conveniently be arranged under two divisions, namely: 1st, methods of contamination; 2d, prevention of contamination.

1st. Methods of contamination can be subdivided into:

(a) Diseases affecting cow, her food and surroundings.

(b) Contamination while being milked and gotten ready for shipment at the dairy.

(c) While being transported and delivered to consumer.

(d) After milk is in consumer's possession.

2d. Prevention of contamination covers a wide field, and can only anywhere near approach perfection by constant, intelligent supervision from the pasture field, watering place, and food trough to its final delivery to the consumer, and after it is in the consumer's hands by general education of the masses in hygiene in general.

In order to more fully put before you the immensity of this traffic, I wish to quote some statistics showing amount of milk used in some of our large cities. It is said that 1,250,000 quarts are used in New York city daily. That would mean milk from about 155,000 cows, and that about 31,000 milkmen have been employed in milking these cows, that 62,000 hands have been used in the work, and that most of them are wet with milk and that a very small per cent have been washed before milking, a fact to which I am sorry to be obliged to call your attention.

In regard to diseases liable to affect the cow, of course tuberculosis holds first place, and in some localities seems to be present to an almost alarming extent.

H. E. Annett's experiments show tubercle bacilli were present in the milk used in the English cities in from 3 to 30 per cent of tests made (inoculation of animals was the test used), and in butter in from 10 to 47 per cent, but that they do not live in butter more than twelve days. Out of twenty-eight samples of oleomargarine they were present but once. This latter observation points to the fact that butter used in the manufacture of oleomargarine is usually more than twelve days old, and the moral would be "eat oleomargarine." It is a well-known fact that a cow can be affected with tuberculosis and yet give non-tubercular milk, in fact, is not liable to do so unless extensive general tuberculosis be present or else tuberculosis of teats, milk glands, or udder exists. It would seem the sensible thing to do, to examine milk and destroy the animal only when she gives milk containing tubercle bacilli, instead of the expensive, not to say questionable, proceeding of slaughtering them because they react to the tubercle serum.

Is there great liability to contract tuberculosis from the use of milk that occasionally contains tubercle bacilli? Or putting it more strongly, is tuberculosis disseminated in the human being by use of tuberculous cow's milk? This opens up a wide field, and no doubt opinions would be very different, yet by a little observation much can be learned.

Tuberculosis is hardly more prevalent or fatal in the United States and England than in Germany, while milk is used raw very largely in the two former, and is very generally sterilized by boiling in the latter country. Woodhead carefully examined 127 children that died of tuberculosis and found the mesenteric glands involved in 100 of them. Osler relates the instance of a milk dealer whose herd was giving tuberculous milk, and withdrew his milk from the market and fed it to a litter of pigs, which all became affected with intestinal tuberculosis. Is there any reason to believe that young children are less susceptible than young pigs? The answer would be modified by two propositions.

We have no direct evidence of such a result, and the bacillus found in cow's milk is not exactly the same as that found in human tuberculosis. Sparsely settled regions, regions of an elevation above 5,000 feet, are almost exempt from this disease. While they probably use as much milk as other people, no doubt immunity plays an important part here, but hardly to such an extent. The American Indian and negro races are especially prone to this disease, although they use a much smaller amount of milk than the white race. Primary intestinal tuberculosis is uncommon in the human being, which would not be the case if it was at all generally produced by milk consumption. Hydrochloric acid or gastric juice is very destructive to the bacillus, and probably under ordinary conditions few, if any, pass through the stomach alive, and provided some do they hardly would infect from the intestine if the mucous membrane were intact. We do not deny the possibility of infection, but the practical question is, how large a proportion of those using tuberculous milk become affected? This can only be answered, in the light of facts before us, by saying that there are not nearly as many as alarmists would have us believe. The writer's opinion, based upon years of observation is, that children who consume much milk during early life, say up to fifteen years of age, are better equipped physically, have less skin and digestive diseases, and really have a lower mortality from all causes, tuberculosis included, than those deprived of this useful food. Cattle are, of course, liable to acute diseases, but fortunately give but little milk during an attack, and the same may be said of most chronic diseases, tuberculosis being the main exception. The disease of milk glands known as garget is quite common, and the average farmer thinks such milk not sufficiently bad to warrant throwing it away, and into the can it goes. Once seeing a farmer emptying a few quarts of this kind into a can, I protested, telling him that it might easily cause some bottle-fed infant to become sick, or, still worse, some sick one to die. He said so small an amount in the whole mass would do no harm, besides he received such a pittance for his milk that he could not afford to throw it away.

New milk (that is the secretion of milk glands for first two or three days after dropping calf) is not generally considered fit for use, but quite generally goes in to enrich the mass sent to cities.

Milk, sometimes even deadly in its virulency, is many times the result of food taken. The most notable example of this is the disease known as "milk sickness," and associated with the disease in cattle known as "the trembles." It has been demonstrated experimentally that an ounce of butter or cheese or four ounces of the meat from these animals, either raw or boiled, given to a dog daily for six days, will produce death. Although the exact cause of the disease is not definitely known, it is generally admitted to be due to some plant consumed by the animal. I believe new countries and certain localities only suffer from this disease.

Digestive diseases are most common during periods of drouth, when cattle are obliged to eat weeds and plants which they avoid when grass is abundant. Marked examples of the influence food has on the quality of milk are those of the milk and butter being scented by the leeks eaten by the cows in certain localities in the Western States, and the unwholesomeness of milk given by cows in cities when fed on cabbage leaves and other garbage. These are so well known that I hesitate to mention them. Those fed on malt and refuse from breweries and distilleries come under the same heading. There should be care of the cows not only in regard to food and water, but also in relation to construction of stables, ventilation, light, bedding, condition especially of stable floor (the latter often are afloat on a reeking mass of filth in latter part of winter and spring months, and in such cases the cow is usually pretty well plastered). This is not overdrawn, but is supported by facts altogether too numerous. Can milk from cows in such surroundings be a good article?

Probably the most prolific source of contamination occurs while milking is being done. Who ever heard of a milkman washing his hands before milking? Most of them wait until they are actually doing the work, and then wash them in the milk. Many times I have seen four dimples in froth on milk in milk pails, two where the streams of milk penetrated, the other two, dark brown ones, where milk drips from hands. Many milkmen think they cannot milk without first wetting teats with milk and consequently persist in this filthy habit. Water is not usually handy to milkyards or stables, consequently udders and teats rarely get washed.

The cow is a restless brute, especially inclined to be uneasy while being milked, occasionally kicks and now and then plants a filthy foot in the milk pail. (Such milk is usually strained before going into the can.) Hair, insects, hay, straw, blood, pus, particles of earth and more or less cow manure constitute the most common foreign elements that get in at this time. It is estimated that New York city consumes thirty tons of cow manure a year in milk. It cannot be entirely prevented, but can be very much lessened, if only more care were taken and result of the evil more generally appreciated. Also, at this time milk often has been made deadly by contamination with disease germs. They get into the milk in a variety of ways; most common, perhaps, is that by washing utensils with infected water. Scarlet fever, diphtheria and typhoid are no doubt often produced by the use of milk so infected. Scarlatina is unknown in countries where cow's milk is not used for food, which many authorities think is due to this source of transmission being absent. A common source of trouble comes from improper cleansing of utensils at this time, minute particles adhering to cans, pails, etc., being a nidus for rapid bacterial development in fresh milk that is added. Milk may contain enough butter fat, solids, be strained, and yet be very bad from this cause alone. The various preservatives such as borax, salicylates, paraldehyde, etc., are all bad and should never be used, and at the best are only a "premium on shiftlessness." Their use cannot always be laid at the producer's door.

Methods of contamination while in the hands of the shipper and dealer are mainly from removal of covers from cans for various purposes, thereby allowing particles of dust and various other minute substances to gain entrance, and quite generally such substances favor bacterial development. To illustrate the care necessary, I once saw some trainmen unloading empty cans at a country road crossing. Beside the track was a ditch filled with stagnant water and mud, and they thought they were having lots of fun by slamming cans in this ditch to see how dirty they could make them. Such a can could again be made fit to put milk in after more work than the average producer would care to give. The rate of multiplication of bacteria under favorable circumstances is such that it would stagger the uninitiated. In very good milk as it comes from the udder, the number is usually from three to four thousand per cubic centimeter, while milk as delivered in the city usually contains from three to six millions per cubic centimeter. After the milk is in the hands of consumer, the methods of entrance of impurities are many; the most common are from unclean dishes, keeping in living rooms, exposure to disease germs and lack of proper facilities to keep correct temperature. Good work in the line of inspection is now being done by the Philadelphia Pediatric Society. A committee has been appointed consisting of a bacteriologist, a veterinarian and a physician. They are noting all the conditions under which milk is obtained. Any farmer or milk producer that allows a thorough inspection once a month is given a certificate if the milk comes up to the standard fixed by the society. This plan at least has the right method in vogue, and will accomplish much good if faithfully carried out.

I understand at the present time the milk inspectors of New York city are appointed under civil service rules, and only the ones passing best examinations are chosen. Since this rule has been in force the relation of the producers and inspectors has been cordial, for the former are sure of fair treatment. Many of our smaller cities are making more or less abortive attempts at milk inspection, principally relying on penalties enforced on the producers when milk does not contain enough solids and butter fat, nothing whatever being done to keep out impurities.

2d. Methods of prevention of contamination that might and should be faithfully and earnestly carried out are many. Hygienic laws that are useful generally are especially useful here, and when more generally understood milk inspection will be greatly simplified. Common honesty would do much to better matters, but unfortunately many individuals are not willing to sacrifice time, work and profits for the sake of keeping conscience clear.

A man that has had his training entirely in the city and has no practical knowledge of farming in general and milk industry in particular, be he ever so well educated, is not the man for this work, for the farmer will find in about one minute that he does not understand the business, and will only listen to his suggestions in a spirit of derision and let the advice, as the old adage is, "go in one ear and out the other."

The man that will sit on a milkyard fence with high collar and patent leather shoes, and ask the farmer if his cows will bite, is not the man to gain the latter's confidence and co-operation.

The above description of the man not wanted also suggests the man necessary for proper work here. A man educated, cleanly in habits, faithful and honest, and willing and anxious to observe every detail and, so far as possible, correct every evil is the man needed.

What has he to do? See that milk is not shipped when contagious disease exists on premises, see that cows have proper food and water, and are healthy, that stables are properly cleaned, lighted and ventilated, cows properly bedded and not confined too continuously, that hands, teats and udders are clean, that the *dry process* be used in milking, that milk utensils are properly cleaned, that no filthy or diseased milk is emptied into can, that a proper strainer is used, that no old milk is emptied into the fresh, that no chemical preservatives are added, that milk is properly cooled before can is covered, that cans are not opened on trains, that the milk does not stand around depots for several hours after being delivered before milk peddlers come to take it away, and that the peddlers do nothing to *improve its quality*, and he might extend his good offices even into the home of the consumer to good advantage.

Examinations for germs aside from tubercle would not be necessary if the foreign substances were kept out. It is not that the producers and handlers of milk do not understand these matters generally pretty well, but they are careless about their proper enforcement, they do not fully realize the great disaster that might easily follow carelessness or dishonesty in any minor detail.

The trite saying, "Eternal vigilance is the price of liberty," might apply here if changed to "Eternal vigilance is the price of pure milk."—Columbus Medical Journal.

## AMERICAN LOCOMOTIVES IN ENGLAND.

By CHARLES ROUS-MARTEN.

APPARENTLY it is inevitable that whenever the slightest reference is made to the recent importation of American locomotives for British railways some ardent but ill-informed patriots should be stung by national jealousy into pouring forth torrents of enthusiastic nonsense. This seems rather a pity, as it is apt to engender ill-feeling, and also to inspire in the minds of foreign critics an undesirable sentiment of contempt in which the innocent as well as the guilty are hopelessly confounded. I am aware that it will be horribly unpopular just now to suggest the slightest doubt that American locomotives have been thoroughly tested in comparison with British engines and have been utterly and finally beaten. Yet I venture to take the risk in the interests of truth and fairness and science.

Nothing can possibly be clearer or simpler than the circumstances of the importation of these American engines. Four British railway companies found themselves so short of locomotive power that their work was seriously impeded, and something like a deadlock was threatened. They put in hand fresh engines to the full capacity of their own workshops, and ordered largely from British makers. But the latter were "full up" with contracts, and required nearly three years for the execution of the orders. In these circumstances what were the railway companies to do? Were they to sit down and wait until a British builder should be at liberty, and meanwhile let their traffic get into a state of deadlock? Some writers seem to think that this course should have been adopted, that at all costs and hazards British railway companies should refrain from purchasing abroad what they cannot get in Britain. Not so thought the railway companies; not so would have thought their customers and those very critics, had such tactics been adopted. Failing to obtain in Britain what they wanted, the railway companies did just as any ordinary customer would have done—they went elsewhere for the articles they required.

Now one form of criticism upon this procedure has been to revile the railway companies for not foreseeing years in advance that a flush of prosperity would come upon the country, and with it an increase of traffic. Mr. S. W. Johnson and Mr. H. A. Ivatt and Mr. H. Pollitt, all are most able men as locomotive engineers, but they are not worth a rush as inspired prophets. They never served their time in any prophetic workshop, and so they have just to content themselves with the mere normal foresight born of common sense, which is the attribute of ordinary mortals. They made such provisions as prudence and experience dictated, and most assuredly their shareholders would have been "down on them" had they done or attempted to do more.

So, the need of engines being urgent, orders were sent to America. At this stage I may eliminate the Great Northern and Great Central and Barry Railways, because what I shall have to say applies more especially to the Midland line. And I desire to say here that I do not write in the smallest degree as a partisan. I have not the slightest interest in praising or defending one engine or one country's engines at the expense of another or others, nor have I the faintest inclination to do so. I recognize no "patriotism" in such a case. I care not whether a locomotive be British or Yankee or French or Double-Dutch. My sole criterion of merit is its performance in relation to its requirements, its conditions, and its nominal power. To all questions of country and person in such a connection I am profoundly indifferent. I seek simply to get at the truth.

The orders, as I have said, were given to certain American firms. Those firms were, I am informed, quite as "full up" of orders as were the British builders. But it is in the United States a breach of the eleventh commandment, and contrary to all recognized principles of commercial morality, to decline a good contract or to "turn ready money away." So these contracts were undertaken without a moment's hesitation. It is not my business to explain how this was managed. But it was. The engines, Mr. S. W. Johnson has stated, in an interview with the representative of a London daily non-technical journal, "were to be of the same power as the Midland standard goods engine, and there were a few small details to which the manufacturers had to conform; but, generally speaking, the Americans had a free hand, and the engines were for the most part of their own design and pattern, and made in their own way."

Let it be noted here that the order was *not* that the locomotives were to be of the class and power that would be employed in America to do the work required, viz., to haul coal trains weighing 500 tons over gradients of 1 in 200 to 1 in 100. No; the American locomotives were to be "of the same power as the Midland standard goods engines." They were duly built and were delivered, Mr. Johnson says, "within a few months of the orders being given," although "some contracts which we let out to British firms in 1897 were not completed till February, 1900"—that, however, was largely due to the engineering strike. And Mr. Johnson continues: "Each American engine cost us £400 less than did those for which contracts were given to British firms immediately in front, and at such a reduction the American engines were put free on our railways just as English engines were."

Almost exactly identical, it will be remembered, was the experience of a British Colony some years ago. An order placed in Britain took two years to complete, and the engines had to be altered. One placed simultaneously in America was executed in five months, at £400 per engine less and without any trouble whatever. But this in passing.

Naturally when the engines were ready for work it became a matter of much interest to see how they would compare with British engines of nominally identical power. There was never any idea of ascertaining whether American engines were "better than British engines." No well-informed or reasonable person ever dreamt for a moment of regarding such an absurd issue as involved in the trial, for a reason to which I shall come directly. Mr. Johnson himself says emphatically, "I never had any doubt in my own mind as to which was the better engine of the two"—that is, of the two classes that were tried in comparison.

Now let Mr. Johnson himself tell what was done. He says: "In January of last year we commenced a six months' comparative test, terminating at the end of June, between these American and our standard Midland goods engines, built by Messrs. Neilson, Reid & Co., of Glasgow, and Messrs. Kilson & Co., of Leeds. The two types were set to draw similar mineral trains under the same conditions, and a careful account was kept of the total mileage covered by each, the total coal consumed, and the charges for repairs which belonged to each engine. The result was conclusive, and is briefly as follows:

"Extra working cost of American engine over English engine:

| | Per cent. |
|---|---|
| Fuel | 20—25 |
| Oil | 50 |
| Repairs | 60 |

It must be said for the foreign engines that they worked their trains satisfactorily, but their inferiority on the three points named is, on the above showing, incontestable."

This result has been variously expressed, but is understood by the non-technical press as implying a complete proof that American engines are inferior to British. Of course, as I remarked before, no such comparison is really involved directly or indirectly by the test employed on the Midland Railway, which in its essence is obviously no adequate means of comparing the different methods of two nations. It may naturally be asked by a superficial thinker, "Is it not a fair comparison to have both engines made as nearly as possible of practically identical power, and then to try them together on identical work?" I reply, unhesitatingly, "No, it is not; unless it be clear that each class of engine is the one that would be used ordinarily for the same work in the land of its origin."

This is obviously so in the case of the Midland engine, which is the outcome of Mr. Johnson's many years' experience and judgment as to the type best qualified to perform the work which has to be done on the Midland line. He has designed and built an engine which is intended to haul 500-ton coal trains, and which does so in a most efficient and economical manner. Its design is not only practically efficient and handy, according to British practice, but it is also symmetrical and handsome in an exceptional degree, and worked—as British engines have to be worked—to the full extent of its capacity, it is probably as perfect a machine as could well be devised for its purpose, within our present knowledge. That may be frankly admitted.

But the point which vitiates the whole comparison between these fine engines and the imported American engines, and equally vitiates all deductions from the result, is the indisputable fact that this type of American locomotive is not, with respect to its dimensions, one which would be used in America for the same duty, viz., to haul trains weighing 500 tons British, or 560 tons American—1,120,000 pounds, as the Americans prefer to express it—at considerable speeds on roads with gradients of 1 in 200 to 1 in 100. For such duty in the United States locomotives of far greater power would be used than these which have only 1,214 to 1,364 square feet of heating surface, 160 pounds steam pressure, and cylinders 18 x 24 inches with 5 feet coupled wheels. An American engineer would assuredly use a boiler with, at the least, 1,750 to 2,500 square feet of heating surface, and 180 pounds steam pressure. Indeed, I believe that these very engines in question were built to use 180 pounds steam pressure, so that to work them at 160 pounds is another handicap in their disfavor. Nor must the fact be overlooked that their piston stroke is shorter by 2 inches than that of their British competitors.

It may reasonably be asked, "Why, if the smaller dimensions suffice for the British engine, should they be insufficient for the American?" The reply is that all American locomotive practice is based upon the principle of allowing a margin of power. In all classes of work this is the rigid American rule, and, in pursuance of that rule, I assert, with considerable experience of American practice in various parts of the globe, that had the American builders been instructed to supply an engine to do certain specific duty, they would not have produced the type now seen on a few British railways, but one of far greater power. And, therefore, as the American locomotives have worked under conditions not suitable to their type, they necessarily have worked under a serious disadvantage. For when you try one locomotive which is specially designed on the spot for particular work against another built in a different country on a different design, and brought into the comparison merely as possessing approximately identical dimensions, you handicap the latter very adversely. Virtually you pit an engine, admittedly and specially suitable for its prescribed duty, against one which, while nominally of nearly equal power, is practically much less strong, because its type and design presuppose it to have a margin of strength which, under these conditions, is absent, and because also its type is only employed in its country of origin for the specified work, with greatly larger dimensions.

Therefore the recent Midland trial only proves that identical dimensions for identical work will not suit engines of totally different designs and modes of construction. But it did not require one to rise from the dead to tell us that. I need hardly say that I implicitly accept Mr. Johnson's figures, and that I am perfectly satisfied as to his desire to make the comparison as fair as possible. I do not touch the question whether the American engines would show as well in the hands of British drivers as when driven by men who had always been accustomed to that type of locomotive. Neither do I touch the question whether British drivers would be anxious to make American engines appear superior to British engines in any such trial. I pass by both of these factors in the problem. I simply say that while on the whole no exception can be taken to the fairness of the methods adopted for trying on the Midland Railway those two different classes of its own engine, such a trial affords no test whatever of the relative merits of British and American locomotives, or methods of locomotive practice.

Another point is raised by some remarks of Sir Ernest Paget, the chairman of the Midland Railway, who also was interviewed on the subject. Sir Ernest said: "The American engines are not as good as ours. They do not cost as much, and they are not so well finished. Under all the circumstances nobody would expect them to be so well constructed. But in America they make their engines on an entirely different principle, and with quite an opposite idea to ours as to their future. In America you go and take an engine off the peg, as it were, and from then onward work it right out till it dies, giving it no rest. Their contention is that by the time it is done for and worn out something better will have come along. On the other hand, we make our engines as good as we possibly can to start with, and then we tend them most carefully, rest them, clean them out, and do everything to make them last."

This raises the whole question—Which plan embodies the wiser policy? It is no doubt an attractive method to make engines as good as possible to start with, and then to tend them most carefully, and do everything to make them last. But it is at least open to argument whether an engine-life thus artificially lengthened be really advantageous to its owners. May it not imply the crowding of a line with ancient locomotives which, while seemingly too good to break up, nevertheless are unable to take standard train-loads, and which consequently necessitate either the use of pilot engines or the running of additional trains? To many working time tables a list is appended of reduced loads which are to be given to the older locomotives. The reduction of a train-load to suit the deficient power of an old engine involves a proportionate addition to the number of trains that have to be run, for the load has to be taken, whether in five trains by new engines, or in six trains by old ones. That the workmanship of the American engines is enormously inferior in point of finish to that of our British engines is too obvious to need demonstration. Indeed, I drew special attention to the fact in my articles on the locomotives at Vincennes, where even the special Exhibition engines displayed in some parts a roughness of finish that was absolutely startling and almost horrifying to British eyes. But if it be asked whether the engines were less efficient for their rougher workmanship, it is not easy to give a satisfactory or conclusive reply. Similarly it is an open question how far the practical usefulness of a locomotive is discounted through the use of cheaper materials for certain parts, e. g., steel for copper in the fire-box, steel for brass or copper in the tubes. The cheaper materials should not last so long. But American builders, as Sir Ernest Paget justly remarked, do not desire their engines to last so long. They deem it cheaper to use them up quickly and build new ones with all the latest improvements. It must be of dubious benefit to have on a railway scores or even hundreds of engines thirty to forty years old, however often repaired and rebuilt.

But on one point I desire to be particularly clear and emphatic. In certain cases an American engine may be found more suitable than a British engine, through the convenience due to the accessibility of its working parts owing to their outside position, and if the American be designed for the particular work it has to do, my experience leads me to believe that it will show results quite as good as those of a British engine. Moreover, it is the American practice to build far more powerful locomotives in proportion to the work required than is done in Britain. But comparing engine with engine on the basis of efficiency per unit of nominal power—reckoning the capacity of the boiler and fire-box, as well as of cylinders and wheels—and also on the basis of performance per unit of nominal power, I am firmly convinced that no locomotive exists in the world that is superior to the British.—The Engineer.

## TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

**Prevention of Frost by Cannon and Smoke.**—The last number of the Gironde, a Bordeaux newspaper which represents the wine growers of that region, contains an article by Mr. Bellot des Minières on the subject of preventing frosts from injuring early fruit. His theory is that it is not the frost which blasts the budding fruits, but the sun's rays following a night of frost and finding in the grape, already sensitive from the cold, an object unable to withstand their heat. After many experiments, which he says have always succeeded, Mr. Bellot des Minières recommends the accumulation at various points in the vineyard of combustible matter, capable of producing a thick, black smoke, and setting fire to these heaps of fuel at sunrise, so that a veil of smoke may cover the entire ground, protecting the vine by its opaqueness against the sun's rays and maintaining the general temperature of the vineyard at a point which will counteract the effects of the frost. The smoke, which acts as a warm blanket, lifts gradually enough for the vine to adapt itself to the changed temperature.

Since I reported on the subject of firing cannon for the prevention of hail storms,* the use of cannon for other allied purposes has been discussed in agricultural circles. Dr. Marangoni, professor of physics at the Royal Lyceum of Florence, Italy, has declared his belief in the efficacy of the use of cannon for the prevention of frosts. He says:

"There are astonishing resemblances between the state of the atmosphere which produces hail and frosts. . . . An absolute calm is necessary for both. . . . In the phenomena of the white frost . . . the calm creates a very cold layer of air near the surface of the earth, saturating the otherwise dry air and at the coldest moment the frost is formed. . . . The important object to be achieved in the case of both hail and frost is to break up the calm before either is formed."

He recommended that the cannon be fired horizontally over the ground to be protected. Under his direction, cannon were fired horizontally over the vineyards of Count Balli, at Asti, and he relates that a strip of vineyard 500 feet wide over which two cannon were fired was entirely protected, while the vines on each side were badly injured by the frosts.

At the central office of the agricultural societies in this part of France, I was told that extensive preparations are being made to test the efficacy of cannon against frost in spring.

One of the gentlemen who is working on this question said to me:

"The frost is formed by the stored heat of the sun combined with an excess of dampness; . . . the firing of the cannon produces perturbations in the atmosphere, causing a slow transition between the coldest hour of the night and the coming of the heat of the sun."

It has just been determined to hold an international cannon congress in Lyons next November, in which this subject will be fully discussed, and I am requested to say that American representatives are invited to be present and to take part in its deliberations.

As an invasion of grasshoppers is announced for this summer in southern Algeria, cannon are to be tried against them also.—John C. Covert, Consul at Lyons.

**German Wine-Trade Directory.**—Consul Schumann sends the following, dated Mainz, April 22, 1901:

It may be of interest to the wine and kindred trades to know that there is published in this city a directory containing the names and addresses of all the wine merchants, manufacturers of sparkling wine, distillers, wine-room keepers, agents, and wine-commission brokers in Germany. The price of the directory is 12.60 marks ($3), postage to foreign countries included. The directory may be obtained from the publisher, J. Diemer, No. 19 Grosse Bleiche, Mainz, Germany.

**Tea in Caucasus.**—Consular Agent Harris reports from Eibenstock, April 26, 1901:

The cultivation of cotton in the Caucasus has been attended with such success that the Russian Government has decided to introduce the culture of tea into that province. In 1900, nine trial plantations were laid out in the districts of Osurgei and Kutais. The results have been such that new plantations will be laid out in the districts of Mingrelien and Sentum. Plants and seeds have been collected for this purpose from the best tea provinces of China.

**Demand for Steel Rails in New South Wales.**—Consul-General Guenther, of Frankfort, May 4, 1901, quotes from German newspapers a dispatch from Sydney to the following effect:

The Government calls for bids for furnishing several hundred thousand tons of steel rails, which shall be manufactured in New South Wales and be delivered within four years. This involves the establishment of large iron works in the colony. A deposit of $48,660 is required as security that the contract will be carried out. It is also stipulated that the price of the rails shall not exceed the price in Great Britain and America, plus the freight.

**Demand for Railway Equipment in Italy.**—Under date of April 29, 1901, Consul-General Guenther, of Frankfort, says that according to the Secolo, the plan for an increase in the rolling stock of the Midland Railroad of Italy has been approved. The plan, says the paper, contemplates the purchase of 30 locomotives, 40 passenger cars of the second class, 90 freight cars, 46 reservoir cars, 50 freight cars (flat cars), and 18 bogie cars, at a total cost of $1,782,000. The rolling material to be abandoned will be replaced or renewed by 32 locomotives without, and 14 with tenders; 2 parlor cars, 30 passenger cars of the first class, and 50 of the third class; 2 bogie cars and 70 closed and 30

* See Advance Sheets Nos. 807, 916, and 946 (Consular Reports No. 241, 246, and 247).

open freight cars. For these, $1,474,500 will be appropriated. Advertisements for bids will be published in the near future. The material must be delivered within from seven to ten months. Eight hundred and fifty cars will also have to be provided for the Midland Railroad to replace those which heretofore have been leased. The Government, however, has not yet arrived at a decision in regard to this last proposition, but will have to do so shortly, as the leases expire this fall.

**New Steamship Lines from Europe to Gulf Ports.**—Rotterdam-Havre-Galveston.—Consul Thackara reports from Havre, May 9, 1901: The Hogan Line, which has from time to time been dispatching freight steamers from Galveston to Havre and Rotterdam during the cotton season, will inaugurate, on May 15 next, an all-year service between the above-mentioned ports. Through bills of lading will be issued to Amsterdam, Ghent, Stettin, and to Swedish and Baltic ports, etc., via Rotterdam. The service will be monthly until the middle of September, when it will be increased by as many additional sailings as the trade requires.

In addition to the steamers for Havre and Rotterdam, others will be dispatched to Rotterdam via Dunkirk or Bremen, if sufficient cargo offers.

The following steamers will compose the line:

| | Tons. |
|---|---|
| Mohawk | 7,850 |
| Manitoba | 7,850 |
| Mineola | 7,850 |
| Monomoy | 7,850 |
| Montauk | 6,000 |
| Matteawan | 6,000 |
| Masconomo | 6,600 |

Information about rates, etc., can be obtained from T. Hogan & Sons, managers, New York; Daniel Ripley, Galveston, Tex.; Langstaff, Ehrenberg & Pollak, Havre, France; and Hudig & Blokhuyzen, Rotterdam, Holland.

Antwerp-Vera Cruz-New Orleans.—Vice-Consul Murphy, of Frankfort, May 4, 1901, sends a translation from the Berlin South American Outlook, as follows:

"The Société des Affréteurs réunis, of Paris and Havre, intends in the near future to establish regular steamship connection between the ports of Antwerp, Havre, Habana, Vera Cruz, Tampico, Progreso, and New Orleans. On the 30th of each month a ship will leave Antwerp, touching at Havre, from which port it will sail on the 5th of the following month.

"The first ship is expected to reach New Orleans on May 15, and will begin the home voyage on June 1."

Leith-New Orleans-Galveston.—Under date of May 16, 1901, Consul Fleming, of Edinburgh, says: The new dock at Leith, to be called the Imperial Dock, which was briefly described in my annual report for 1899, will be opened in June or July next, affording accommodation to the larger class of vessels in the American and eastern trades, which carry from 7,000 to 10,000 tons of cargo. Soon after the opening of this deep-water dock, a line of steamers, consisting of four vessels of from 8,000 to 10,000 tons burden, will be established by the North Atlantic Steamship Company, Limited, to ply between Leith and New Orleans and Galveston. The special object of this line is to carry grain and cotton. These vessels are to run during the season only—that is, from September to March, inclusive, each year. The time from New Orleans to Leith will be about twenty-five days.

**Demand for Electric Machinery in Spain.**—Consul-General Guenther, of Frankfort, under date of April 27, 1901, says that, according to Informations et renseignements de l'office national du commerce exterieur, a new electrical company, the "Sociedad General Gallego de Electricidad," has just been formed in Madrid, Spain, with a capital of 2,000,000 pesetas, and two of its engineers, Messrs. Ernsto Presser and Adolfo Barbe, of Madrid, have been instructed to procure the necessary machinery, etc.

According to the same publication, another company has also been formed at Saragossa—the "Sociedad de Aprovechamiento del Rio Gallegos—with a capital of 3,500,000 pesetas. This company will require a great deal of machinery and apparatus.

**Canadian Bounty on Pig Lead.**—Consul-General Turner reports from Ottawa, May 23, 1901, that Parliament has ordered a bounty on pig lead manufactured in Canada: $5 to be paid per ton for the first year, $4 for the second year, $3 for the third year, and thereafter $2 per ton for fifteen years; the amount of bounty not to exceed $100,000 for any one year.

## INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

**No. 1064, June 17.**—Tin-plate Industry of Wales.—Mining Concession in Southern France.—* Gas Water Heater in France.—American Office Furniture in the Netherlands.—Railway Contract in Guatemala. Textile Plants in Salvador.

**No. 1065, June 18.**—* Drawbacks to American Bicycle trade in England.—New Paper Factory Near Nice.—Demand for Artesian Wells in Venezuela.—New Railways in British Columbia.—Maltese Tobacco Trade.—Railway Concessions in Nicaragua.—Tea Trade of China in 1900.—Foreign Commerce of Chile, 1900.—* Olive Crop in Southern Europe.—Tolls in Persia.

**No. 1066, June 19.**—* Austro-Hungarian Commercial Expedition.—Belgian Coal Market.—New Food Plant in Africa.—Boat stopping Apparatus in Norway.—German Trade with South America in 1900.—New Method for Producing Anæsthesia.—German Device for Removing Slag from Grates.—Russian Tariff Changes.—United States Trade with Ecuador.

**No. 1067, June 20.**—* Competition for Automatic Lorry in Great Britain.—* Canal Project in Austria.—Utilization of Water Power in Austria.—American Coal at Malta.—Market for Blotting Paper in Germany.—* Trade Notes from Nice.—* Liquid Bronze in Germany.—Export Rebate on German Fuddle Steel. Consumption of Horse Meat in Frankfort.—Denmark's Commerce with Greenland.—New German Veneer.

**No. 1068, June 21.**—The German Leather Industry.—Commercial Progress in Paraguay.—Colombian Export Dues.—Industrial Conditions in Roumania and Servia.—Draining the Zuider Zee.—* Well-Boring Machinery and Windmills in Yucatan.—Credit of Roumanian Business Houses.—Oriental Carpet Trade.—Carriages in the Netherlands.—American Products Abroad.—Opening for Bags in Hungary.—Russian Northern Railroad.

**No. 1069, June 22.**—The Impending Deficit in German Breadstuffs.—Coal in East Siberia.—Obstacles to American Bicycle Trade in France.—Exposition of Fisheries at St Petersburg.—Demand for Milk Vessels in Siberia.—Commercial School at Cologne.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.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## TABLE OF CONTENTS.


PAGE

I. AERONAUTICS.—The Use of Oxygen in Balloon Ascensions.—2 illustrations. 21338

II. ARCHÆOLOGY.—The Excavations at Timgad.—3 illustrations. 21329

III. CIVIL ENGINEERING.—Protection of Ferric Structures.—By M. P. WOOD. 21332
Railways in Japan.—1 illustration. 21334
Remarkable Railway Crossing. 21334

IV. ELECTRICITY.—Electrolysis of Water and Gas Pipes. 21337

V. FUELS.—Mond Fuel Gas in Great Britain. 21334

VI. MECHANICAL ENGINEERING.—American Locomotives in England.—By CHARLES ROUS-MARTEN. 21340
Locomotive Crank Axle Slotting Machine.—1 illustration. 21331

VII. NATURAL HISTORY.—Food of Sea Lions. 21335
The American Giant Otter in the Berlin Zoological Gardens.—3 illustrations. 21335

VIII.—NAVAL ARCHITECTURE.—New Russian High-Speed Cruisers.—2 illustrations. 21330

IX.—PHOTOGRAPHY.—Progress of Photography. 21336

X. SANITARY SCIENCE.—Milk Contamination and How Best to Prevent it.—By D. S. HANSON, M.D. 21339
The Dame, Pottevin and Piat Pasteurizing Filters.—3 illustrations. 21339



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